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BULLETIN

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CONVENTION ON THE INTERNATIONAL REGIME OF RAILWAYS.

The Second General Conference on communications and transport which met at Geneva, adopted on the 3 December 1923, the Regulations and Statutes dealing with international railway matters.

In view of the great importance of these Regulations, which include all the arrangements made as regards the various railway problems, and which will become so to speak the international standard in this respect, we are glad to be able to publish the complete text. This text is preceded by the report of the Committee appointed to consider these Regulations.

(*Editorial note*).

I

Report by Messrs. Isabelle and Pacaud, reporters of the Railways Committee.

I

Gentlemen, the text of the Convention which your Committee on railways has the honour to submit for consideration by the Conference is only the ultimate consummation of the proposals which were considered at great length by the Advisory and Technical Committee for Communications and Transit.

This final version of these proposals is only of real importance so far as the equitable treatment of commerce and jurisdiction are concerned; indeed these are questions of an essentially political nature, in respect of which the Technical Committee could only make preparations for their consideration, and which can only be settled by a large gathering of representatives of states similar to your own.

In view of the elaborate and detailed nature of the text which is proposed to you and of the brief nature of the draft that was submitted to the first general Conference on Communications and Transit, you will certainly wonder whether you are not being asked to enter into a field other than that in which the Barcelona Conference had taken the first — and a very prudent — step.

That is not the case, gentlemen. The Committee of Enquiry responsible for the preparatory work for Barcelona had

already realised that for the conception of carriage under equitable condition of international traffic on the railways of all States, corresponding to a principle of purest justice, in that conception the carriage itself nevertheless depended on conditions of fact which are no more nor less than the « general conditions of working and utilisation of these lines ».

The Barcelona Conference also had very properly stated that a general Convention on Railways concluded under the auspices of the League of Nations could not constitute a text operative in itself, and that it would only acquire that character by the addition to it of much more detailed agreements, and that all agreements of this nature which were entered into before or after the general Convention would have to be accepted by the said Convention as constituting in law its own annexes and in fact its indispensable instruments of execution.

The draft which is before you, gentlemen, embodies exactly this very conception. It not only meets it more effectively, which is obvious, but if I may say so, it corresponds more exactly than the very text of the recommendations which were the result of the discussions at Barcelona. It is quite easy to see the reasons which led your predecessors to confine themselves to these provisional conclusions. They were debating in the midst of the disturbances which reigned at that time in the transport world as a result of the Great War. They were, therefore, essentially aspiring towards a better future, a future of which they were not the masters. They could only attempt to guide the course of events for the best, they could only « recommend », showing nevertheless, a splendid confidence in the efficacity of its own efforts and in the action which would continue them. The Barcelona Conference desired to look forward to a future when the imperfect light in which that Conference had itself worked would soon be replaced by a real light. That Conference had even limited the period of time, and had come to a definite decision, stating that the task which it has only been able to forecast would be carried out by you in the short period of two years.

II

Gentlemen, you will not betray the trust that has been placed in you. The veterans of Barcelona are here as witnesses of what might almost be called a promise. That promise must be fulfilled within this year. I am sure that you desire to return to your own countries with the deep satisfaction of having been faithful to a very noble undertaking.

We have just reminded you, gentlemen, that the Barcelona Conference had been of opinion that the General Convention on Railways should take into account the general conditions of working and utilisation of these lines.

The most original feature of the draft which is now submitted to your consideration is certainly that it carried this conception to its logical conclusion. It must be evident that this step was absolutely necessary seeing that there certainly existed a common law in respect of international traffic, but only in a latent condition resulting from the comparison and connexion with each other of a large number of agreements, some of them between states, but most of them between railway administrations, so that this common law is not therefore formally laid down in writing, which constitutes a serious deficiency in international law as a whole.

It would take too long to demonstrate this to you here, but it has been more than adequately proved by our Committee of Experts and the Advisory Committee. In these Committees it was also shewn by definite examples how such a situation might be harmful to the interests of international relations.

It is true that when studying the *Green Book* certain specialists have sometimes occasionally thought that its contents

might be useless as they were well-known and accepted by all specialists, but indeed it is very dangerous that legal principles of such great importance should remain exclusively reserved to specialists, and there are certain dangers connected with this which specialists themselves have not always been able to avoid.

At the outset of the work which is before you at this moment, the principle was laid down that it would include a summary of the principles of law as it stands at present in respect of transport by rail. Of course, there can be no question of a real codification; the wisdom of our friend Dr. Hérold, who already presided over our very first small Committee of Experts, was sufficient to prevent us from entertaining any such foolish ambition. It was necessary for us to have a less pretentious outlook. Had the eminent delegate for Greece, whose accurate logical mind your Committee has many times appreciated, been among us, he would have approved our policy of only tracing the outline of existing Conventions. Dr. Lankas, whose absence from this assembly we all regret, being more inclined to poetical ideas, described our undertaking when he said that we were casting the mantle of the General Convention of the League of Nations over all the existing agreements between States and between Administrations. That was the procedure which was followed. The experts first carried out a work which had never yet been done, in compiling and co-ordinating the whole of the great mass of material contained in the various Conventions. It was then possible from this mass, apparently confused but at the same time put in order, to obtain the essential basis for work. This was the task first of the Railway Sub-Committee and then of the Advisory Committee.

Your Committee found itself in the fortunate position of being called upon only to make a few slight alterations in drafting; it had no need to add anything or remove anything from the numerous articles which were submitted to it as an embodiment of the principles of existing international law.

The form in which these articles are presented to you is in no way artificial. Each part of the Convention has its exact parallel in one of the main departments of a railway administration.

Thus, the first chapter of Part I corresponds to the department dealing with tracks and construction.

The second chapter stands for technical working.

Part II corresponds to the train and rolling stock department.

Then comes the execution of the transport contract (Part III), which corresponds to the commercial branch.

Part IV bears the actual name of the tariffs department.

Nothing remains but the departments dealing with financial affairs and litigation, and these form the subject of Part V.

To gain a clear idea of this arrangement, it is only necessary to read the Convention. With regard to the matters of detail, we propose merely to mention those points to which your Committee has decided that your attention should be drawn.

III

In Article 1 of the Convention, your Committee thought it necessary to suppress a paragraph which provided that every contracting State should have assured itself that the railway administrations under its authority accepted the provisions of the Statute. This formula was omitted as having no legal value. Nevertheless its purport is to be borne in mind. Although the obligations of the Statute are undertaken by Governments, railway administrations will frequently be called upon to put them into effect; it has indeed been necessary, in order to arrive at a satisfactory text, to make explicit mention of these administrations in many articles in the Statute.

The first part of the Statute, which relates to the junction of international lines and to working arrangements for international traffic, calls for no special remark, except in connection with Article 4, which will be dealt with later.

The Austrian delegate, however, was anxious to make it clear with special reference to Article 6 that the facilities to be given to international traffic should not entail for any country expenditure in excess of its financial resources. This is, of course, obvious in regard both to this article and to others. The resources — even the exceptional resources — which each country is called upon to place at the disposal of international traffic cannot be other than the fullest resources at the country's disposal at any given moment, having regard to the condition of its railway system. Your Committee was extremely anxious to satisfy the scruples of the eminent representative of a young Republic in which the League of Nations takes a special interest and which is now on the high road to recovery; and your rapporteurs have, therefore, been instructed to dwell upon this subject in their report.

The second part of the Statute, which relates to the mutual use of rolling-stock and to technical uniformity, gives occasion, however, for certain explanations.

In the first place, in order to ensure consistency in the wording of the Statute and to meet the wishes of several Delegations, the obligation in Article 9 as to mutual use of rolling-stock was defined in the same comprehensive terms as were employed in connection with the other technical obligations embodied in the Statute.

As conventions relating to technical uniformity may be concluded either between States or between railway administrations, Article 10 has been amended to this position. The proposed wording implies that technical uniformity shall only be compulsory in respect of these elements of construction which must necessarily be uniform if material is to be exchanged, without, however, discouraging attempts at uniformity in respect of other elements which may be of importance.

Article 12 deals with the immunity of rolling-stock from seizure; it is made clear that motive power is to enjoy the same immunity. This also applies to certain movable articles belonging to an administration and contained in the rolling-stock; your Committee decided that it should be pointed out in the present report that the articles in question should comprise fittings and other movable accessories of the rolling-stock and also such parts of the rolling-stock as can be dismounted.

Article 13 relates to private wagons, which are defined as follows : « The wagons *of* private persons or organisations, other than railway administrations. » The notion of property has been deliberately withdrawn; for in actual fact a wagon which belongs to an administration and is hired by a private person is a private wagon; and on the other hand, if an administration hires wagons which are not its own property, these wagons are not regarded as private wagons but as wagons of the administration.

The third part of the Statute, which deals with the relations between the railway and its users, has been subjected only to formal alterations.

It is to be noted, nevertheless, that the attempt towards unification which is provided for in Article 14 does not solely apply to legal texts, such as that of the Berne Convention, which lays down the principles of the single transport contract; it should also be extended to the conditions under which such a contract is carried out, first to conditions of a general nature such as the « supplementary conditions » and then to the special conditions, which are laid down as conditions of application of the tariffs.

The fourth part of the Statute which

deals with tariffs will be considered later.

With regard to the fifth part, which deals with transactions of a financial character, it is sufficient to point out here that the measures referred to at the end of Article 28 for the prevention of improper speculation which might be carried on by certain intermediaries may be taken either by action which the railway administrations may be able to take against such intermediaries or by means of the putting into force of the laws with regard to improper speculation which may be contained in the various national Legislations.

IV

Only a few days ago we might have terminated this treatise, as regards the technical provisions included in the Convention on Railways, by stating that these principles drawn essentially from the practice of continental Europe, might possess some value as an example for other nations and induce them to conform to a greater extent to these conceptions, which long practice has proved to be satisfactory.

But now it would be no longer fair to say this.

On the 23rd of last month Sir Francis Dent, to whose presidency we all owe so much, asked to be allowed to quit the presidential chair for a moment, and this he did in order to be free to make the following important statement : « For my part, I hope that the States parties to the Berne Convention will accept the adherence of Great Britain and that the British railways will participate. I do not think that this should present any serious difficulty. »

« Enthusiastic » is the only word which can adequately describe the discussions of the Committee — an enthusiasm which increased when the Delegate of China made a similar declaration with regard to his country; the *Green Book* has shown you that Japan and China are both acting on the recommendations of the Berne Convention.

Finally, gentlemen, your rapporteurs feel justified in encouraging you to hope that the same happy results will be obtained in the Iberian peninsular.

It is therefore no longer true to say that the Convention on Railways may possess some value as an example for the future. A noble immolation has preceded the example. The Convention has produced results before actually coming into existence.

V

Hitherto, Gentlemen the provisions which we have examined are quite the opposite of revolutionary, since they are consecrated by large numbers of partial agreements. Now on entering the domain of the Equitable Treatment of Commerce, are we about to embark on a perilous voyage among uncharted shoals ? We do not think so, and alas once again, we have nothing new to offer you. How could it be otherwise ? Very few railwaymen here present could have afforded to await Article 23, Sub-Section (*e*) of the Covenant before becoming honest men. In addition to obligations arising out of conventions, there are in force certain unwritten rules governing procedure in international railway traffic. If these rules have not been committed to writing, this was probably because it was difficult to do so. Now the only novelty of Article 23 (*e*) is precisely that it obliges us to commit them to writing. An admirable French poët, Alfred de Vigny, has consecrated his entire work to the religion of honour. Doubtless, if some covenant had obliged him to extract from his works his rules of honour and express them in a few lines to be inserted in an international convention, his whole genius would have been hard put to it.

Gentlemen, the spirit which has anim-

ated your Committee, the great goodwill and the keen desire for mutual agreement have proved to be more efficacious than genius itself and the Committee offers you the solution for which the covenant provides.

Let us now consider its essential point :

The first paragraph of Article 20 lays down the principle of freedom of tariffs, which corresponds on the onehand to the free play of the economic laws and on the other to the independence of national sovereignty : this freedom is, however, subject to certain limits and must stop short of making international traffic the victim of unfair treatment.

Your Committee desires to reserve that in accordance with the current French use of the terms when employed alone, it has used the word « trade » to indicate all economic activities — agricultural, industrial, or purely commercial — and the word « competition » in its widest sense, having alike in view the competition arising between the transport and a general commercial competition.

The second paragraph contains a stipulation and a prohibition.

The stipulation which is inspired by the British legislation is that reasonable tariffs should be granted to international traffic. The question of reasonableness can obviously only be decided as in English law in the light of circumstances and in accordance with rules of equity in each individual case. It is obvious that the tariff normally applied by a State to its own nationals and to the least favoured of them must always be regarded as a reasonable tariff for international traffic. Consequently there can be no obligation to apply in the case of international traffic any exceptionally reduced rates which may be granted in the case of national traffic to certain products or on certain routes.

The prohibition relates to unfair discrimination based upon considerations of nationality. Your Committee would have preferred not to use these rather brutal expressions in the Convention. It has been forced to do so inasmuch as it could not apply to disingenuous practices more polite expressions than such practices themselves.

The last paragraph of this Article deals with tariffs which are common to railways and navigation. There is, apart from cases in which vessels belong to a railway administration or in which such an administration subsidizes a navigation company, a kind of contract between two parties which pre-supposes a regular service of vessels, a spirit of mutual confidence, and often a community of interests which necessarily give rise to the exercise of perfectly legitimate discrimination in favour of vessels flying a particular flag, as a rule the national flag.

Ought one to limit the advantages of these stipulations to cases in which the carriage of goods is effected by the railway alone in execution of a single contract? Your Committee felt that it could go further by adopting the text of Article *d*. When the carriage of goods is effected by successive contracts and possibly by means other than the railway, it may receive the same advantages as if it were effected on the basis of a single contract, provided that all the conditions which would have enabled a single contract to be drawn up in the case in question have been fulfilled and that the successive carriers have all been advised accordingly.

Finally, the question arose whether unfair national discrimination might be exercised in respect of particular goods by reason of the fact that they had been stored in a port : Article *e* determines this question in the negative.

It will be observed that the international obligation imposed by this Article may apply to goods transported from a port of a country to the interior of the same country or *vice versa, i. e.* to the carriage of goods in the course of national traffic.

To sum up, your Committee has first of all laid down rules for the equitable treatment of commerce as regards international railway traffic. Realising that the conception of international traffic contained in Article 23 (*e*) of the Covenant is wider, it has extended the application of these rules so as to include cases in which national railway traffic is only the commencement or the conclusion of international traffic — these expressions being employed in the widest sense.

Your Committee much regretted that the Lithuanian and Latvian Delegations could not see their way to accept this wider conception.

All the above dispositions apply to tariffs; analogous provisions have been inserted in Article 4 in respect of the facilities to be given to the carriage of international traffic.

We are reminded of the proverb which Sir Hubert Llewellyn Smith quoted to us and indeed we are not bringing you a very big loaf. Still the small loaf that we are laying on the Conference table is a whole one. It will be worth taking home, particularly if you take into account the satisfaction that you will derive from the sacrifices that have been made with a view to obtaining a good understanding between nations. Is not that the spiritual and, so to spreak, the daily bread of international co-operation?

VI

The sixth and last part of the Statute consists of provisions of a general nature. They are for the most part based on drafts already adopted in the previous conventions of the League, and in particular in the Statute on Freedom of Transit.

We may therefore pass at once to Articles 36 and 37, which regulate the question of jurisdictions.

It is laid down in these articles that, in the first place, all steps shall be taken to settle disputes by means of friendly arrangements : provision is made in particular, that under very accurately defined conditions recourse for an advisory opinion may but need not be had to the Committee for Communications and Transit.

In the absence of such an arrangement the dispute shall be compulsorily settled either by the Permanent Court of International Justice or by arbitration procedure. The settlement shall be made by the Permanent Court if the parties agree to refer the dispute to it, or if both parties have, in virtue of Article 36 of the Statute of the Court, declared that they recognise its jurisdiction as compulsory *ipso facto*, and without special agreement. In all other cases recourse to arbitration procedure shall be compulsory.

Should the parties fail to agree as to the procedure to be adopted, it is laid down by Article 37 under conditions which may be summed up as follows : That all difficulties as regards the setting up of the arbitration tribunal or the arrangement of the arbitration settlement are to be solved by a unanimous decision of the Council of the League of Nations.

The delegate of Greece strongly objected to this, and asked that the present report should include his statement to the effect that, in theory at least, the dispute shall not be regarded as settled if unanimity is not reached. Nevertheless, the Committee based its view on the following arguments : Disputes connected with traffic by rail — a matter to which your Chairman referred in eloquent terms at the very beginning of the discussions — may prove to be of great importance and exceedingly complex; the award given may involve far reaching consequences, which may perhaps have been entirely unforeseen at the outset of the dispute and which may affect the vital interests of different nations. It is, of course, important that, just as in each country there is an authority to which matters connected with national traffic are referred for settlement, the members of the League of Nations should have a supreme authority to which the injured party may

appeal in questions of international traffic. In an appeal of this kind, it is no less important to guard against very real dangers, which may even imperil the authority of the *res judicata*, and of the judge himself. The Committee did not see its way to accept any guarantee less effective than that afforded by a unanimous decision of the Council of the League itself, since, from the juridical point of view, such unanimity is provided for by the Covenant, and in actual practice has always been attained.

Nevertheless, arbitration remains the usual procedure which the Committee proposes for your adoption and also remaining the only obligatory one. The British Delegation pointed out that in its view more frequent recourse to the Court of International Justice would be more favourable to the building up of a legal practice. The Polish Delegation expressed the view that the decisions of a number of arbitration tribunals would be no less effective in gradually building up such a sound legal practice. These different points of view were reconciled by the adoption of a supplementary procedure based on British law. When an arbitration case is in course of settlement, the Court of International Justice may be asked to give a kind of provisional award, but only in respect of a question of international law and on a point affecting the juridical interpretation of the Statute. Moreover, this procedure is to be optional and the parties need not have recourse to it if they consider that the arbitration tribunal which they have agreed to accept possesses both technical and juridical competence and will on its own authority give a decision both on questions of fact and on questions of law.

Article 38 merely reiterates the principle already expressed by the Barcelona Conference that a general railway convention can in practice only be carried out through the establishment of special executive agreements, many of which have already been established. Nevertheless, the Committee avoided using the term « Conventions of execution » in order to make it quite clear that the jurisdictions provided for are based on the Statute alone and not on any part of a special convention.

Articles 39 and 40 are those proposed to you by the Advisory and Technical Committee itself with a view to laying down the essential rules governing the relations between railways and other methods of transport and in particular — following an already accepted practice — to enable traffic using other means of transport to be included, if necessary, in one and the same regime with railway transport.

On the other hand the Committee considered that Article 41, relating to existing conventions which may conflict with the provisions of the Statute, should be so drafted as to avoid placing any obstacle in the way of subsequent ratifications of the Convention, however belated.

Lastly, Article 42, which is subject to the provisions of Article 24 of the Covenant in so far as these provisions are obligatory, was unanimously accepted, the eminent Director of the Office Central of Berne also adding his acceptance.

The Committee further notes with particular satisfaction the eminently sound and cordial declarations made by Dr. Dinkelmann. It was particularly gratifying to hear from the lips of the greatest and most experience authority on international traffic that the Committee had done good work.

VII

Such, Gentlemen, is the Draft Convention on Railways. Once more it makes no innovation; it is only a mantle covering existing agreements and the unwritten laws of loyalty in international traffic.

And, moreover, this mantle is not a

heavy one, it is rather a light covering such as befits the youth of our Convention.

We might have gone to work differently; the Advisory Committee thought fit to place before the Committee a part of the preparatory work of its experts in the form of special notes and annexes; these are clearly much more detailed and precise than the General Convention. It is like the studies of detail of great painters, the finish of which surprises, because in the final painting it has been effaced, its purpose being only to act as a framework for the simplicity of outline suitable for a great fresco. And it is precisely a great fresco which it has been the desire of your Committee to place before you.

By adopting this procedure, it has obtained most important results, on which, in conclusion, I desire to lay stress. At the beginning of the work of the Advisory Committee, it appeared unwise to aim at establishing a Convention which was not purely European and it was hoped that subsequently a certain number of principles might be evolved from such a Convention and embodied in a brief Statute applicable to all the nations Members of the League. Owing to the fact that our work has been conducted on lines of constant simplification without abandoning the ample proportions of a universal scheme, it has been possible to submit to you to-day a single and worldwide Convention.

To those who regret the present indefiniteness of our work and the elasticity of the obligations which it contains, I would reply that men who aim at hasty realisation are also men of little faith. Rome was not built in a day, but its founders believed that they were laying the foundations of the Eternal City. The League of Nations, Gentlemen, can also afford to wait.

Your Committee is well aware that the work will have to be placed on the stocks again; and that, although it is based on the principles of pure equity, it is largely experimental and must therefore develop as experience is gained, that is to say, it must keep pace with the evolution of international traffic. Hence, the Committee proposes that you should adopt special rules for revision: it lays down that such revisions should take place at short intervals, for it considers that they are rungs on the ladder of constant progress.

Gentlemen, you will no doubt entrust the task of ensuring this progress to the new Advisory and Technical Committee which you are going to elect. Your President made this suggestion in his opening speech. His words conjured up the vision of impartial experts taking up pencil and rubber, harmonising the practice of America and the Far East with the practice of Europe, and redrafting « Special Notes » to sketch the outlines of the future. Their work is modest but brings its own reward. A man may deem himself happy indeed, if, after accomplishing it, he has the inestimable honour of proposing its final consummation from this platform.

II

Convention and Statute on the international regime of railways.

(These Regulations are not to come into force until the 31 October 1924; the names of the parties and of their representatives being affixed at that date in alphabetical order.)

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Desirous of making provision to secure and maintain freedom of communications and transit, and of promoting for that purpose international co-operation in the organisation and working of railway traffic;

Being also desirous of ensuring the application of the principle of the equitable treatment of commerce to the intertional regime of railways;

Considering that the best method of achieving their present purpose is by means of a general convention to which the greatest possible number of States can later accede;

Recognising that international agreement in respect of railway transport has already been the subject of many special conventions between States and between railway administrations, and that it is precisely by means of such special conventions that international co-operation in this domain can make the most effective progress in the practical application of principles established by a general convention;

Considering, however, that, so far from limiting the effect and scope of such special conventions or interfering with direct relations and negotiations between railway administrations, or in any way affecting the rights of sovereignty or authority of States, it is, on the contrary, by a concise and systematic codification of recognised international obligations in respect of international railway traffic that the principles already established between certain States or certain administrations can be given the widest possible extension, and that in the future the conclusion of new special conventions, to suit the requirements and developments of international traffic, can be facilitated in the greatest possible measure;

And whereas the Conference which met at Barcelona on 10 March 1921, on the invitation of the League of Nations, recommended that a General Convention on the International Regime of Railways should be concluded within a period of two years; and whereas the Conference which met at Genoa on 10 April 1922, requested, in a resolution which was transmitted to the competent organisations of the League of Nations with the approval of the Council and the Assembly of the League, that the International Conventions relating to the Regime of Communications contemplated by the Treaties of Peace should be concluded and put into operation as soon as possible; and whereas Article 379 of the Treaty of Versailles and the corresponding Articles of the other Treaties provided for the preparation of a General Convention on the International Regime of Railways;

Having accepted the invitation of the League of Nations to take part in the Conference which met at Geneva on 15 November 1923;

Anxious to bring into force the provisions of the Statute relating to the International Regime of Railways adopted thereat and to conclude a General Convention for this purpose :

The High Contracting Parties have appointed as their plenipotentiaris :

. . . . . .

who, after communicating their full powers, found in good and due form, have agreed as follows :

Article 1.

The Contracting States declare that they accept the Statute on the International Regime of Railways annexed hereto adopted by the Second General Conference on Communications and Transit which met at Geneva on 15 November 1923.

This Statute shall be deemed to constitute an integral part of the present Convention.

Consequently, they hereby declare that they accept the obligations and undertakings of the said Statute in conformity with the terms and in accordance with the conditions set out therein.

Article 2.

The present Convention does not in any way affect the rights and obligations arising out of the provisions of the Treaty of Peace signed at Versailles on 28 June 1919, or out of the provisions of the other corresponding Treaties, in so far as they concern the Powers which have signed, or which benefit by, such Treaties.

Article 3.

The present Convention, of which the French and English texts are both authentic, shall bear this day's date, and shall be open for signature until 31 October 1924, by any State represented at the Conference of Geneva, by any Member of the League of Nations, and by any States to which the Council of the League of Nations shall have communicated a copy of the Convention for this purpose.

Article 4.

The present Convention is subject to ratification. The instruments of ratification shall be deposited with the Secretary-General of the League of Nations, who shall notify their receipt to every State signatory of or acceding to the Convention.

Article 5.

On and after 1 November 1924, the present Convention may be acceded to by any State represented at the Conference referred to in Article 1, by any Member of the League of Nations, or by any State to which the Council of the League of Nations shall have communicated a copy of the Convention for this purpose.

Accession shall be effected by an instrument communicated to the Secretary-General of the League of Nations to be deposited in the archives of the Secretariat. The Secretary-General shall at once notify such deposit to every State signatory of or acceding to the Convention.

Article 6.

The present Convention will not come into force until it has been ratified in the name of five States. The date of its coming into force shall be the ninetieth day after the receipt by the Secretary-General of the League of Nations of the fifth ratification. Thereafter, the present Convention will take effect in the case of each Party ninety days after the receipt of its ratification or of the notification of its accession.

In compliance with the provisions of Article 18 of the Covenant of the League of Nations, the Secretary-General will register the present Convention upon the day of its coming into force.

Article 7.

A special record shall be kept by the Secretary-General of the League of Nations showing, with due regard to the provisions of Article 9, which of the Parties have signed, ratified, acceded to or denounced the present Convention. This record shall be open to the Members of the League at all times; it shall be published as often as possible, in accordance with the directions of the Council.

Article 8.

Subject to the provisions of Article 2 above, the present Convention may be denounced by any Party thereto after the expiration of five years from the date when it came into force in respect of that Party. Denunciation shall be affected by notification in writing addressed to the Secretary-General of the League of Nations. Copies of such notification shall be transmitted forthwith by him to all the other Parties, informing them of the date on which it was received.

A denunciation shall take effect one year after the date on which the notifi-

cation thereof was received by the Secretary-General, and shall operate only in respect of the notifying State.

Article 9.

Any State signing or adhering to the present Convention may declare, at the moment either of its signature, ratification or accession, that its acceptance of the present Convention does not include any or all of its colonies, overseas possessions, protectorates or overseas territories under its sovereignty or authority and may subsequently adhere, in conformity with the provisions of Article 5, on behalf of any such colony, overseas possession, protectorate or territory excluded by such declaration.

Denunciation may also be made separately in respect of any such colony, overseas possession, protectorate or territory, and the provisions of Article 8 shall apply to any such denunciation.

Article 10.

On the expiration of each period of five years after the coming into force of the present Convention, its revision may be demanded by five Contracting States. At all other times revision of the present Convention may be demanded by one-third of the Contracting States.

STATUTE.

PART I.

Interchange of international traffic by rail.

CHAPTER I.

Junction of international lines.

Article 1.

With a view to establishing such connections between their railway systems as are demanded by the requirements of international traffic, the Contracting States undertake :

In cases where the said railway systems are already in contact, to provide for a through service connecting the existing lines wherever the needs of international traffic so require;

In cases where the existing connections are not sufficient to meet the requirements of the said traffic, to communicate to each other without delay, and to examine together, in a friendly spirit, their schemes for the reinforcing of existing lines or the construction of new lines the junction of which with the railway systems of one or more Contracting States, or the extension of which on to the territory of one more Contracting States, would meet such requirements.

The foregoing provisions do not involve any obligation affecting lines constructed in the interests of particular localities or of national defence.

Article 2.

In view of the general importance to users of railways, and in particular to passengers, of performance of the various exit and entry formalities at the same place, those States which do not feel themselves prevented from doing so by considerations of another nature shall endeavour to secure this object either by establishing common frontier stations, or at least common stations for traffic in each direction, or by any other suitable means.

The State on whose territory the common frontier station is situated shall afford to the other State every facility for establishing and working the offices necessary for the services indispensable to international traffic.

Article 3.

The State on whose territory the junction lines or frontier stations are situated

shall, without prejudice to its rights of sovereignty or authority, which shall remain intact, afford to the State officials or railway employees of the other State support and assistance in the exercise of their duties with a view to facilitating international traffic.

Chapter II.

Working arrangements for international traffic.

Article 4.

Recognising the necessity of granting sufficient elasticity in the operation of railways to allow the complex needs of traffic to be met, it is the intention of the Contracting States to maintain unimpaired full freedom of operation while ensuring that such freedom is exercised without detriment to international traffic.

They undertake to give reasonable facilities to international traffic and to refrain from all discrimination of an unfair nature directed against the other Contracting States, their nationals or their vessels.

The benefit of the provisions of the present article is not confined to traffic governed by a single contract; it extends also to the traffic dealt with in Articles 21 and 22 of the present Statute subject to the conditions specified in the said articles.

Article 5.

As regards the facilities to be afforded to international passenger and baggage traffic, services shall be so organised that the time-tables shall be more favourable and the conditions of speed and comfort shall be better, in accordance with the greater importance of the traffic movements with which such services deal.

The States shall encourage the establishment of through trains or, failing through trains, the running of through carriages on the main international traffic routes, and all other measures calculated to make travel on the said routes particularly speedy and comfortable.

Article 6.

As regards the facilities to be afforded to international goods traffic, services shall be organised in such a manner as to ensure conditions of speed and regularity in accordance with the importance of the traffic carried.

The States shall encourage technical measures of all kinds calculated to ensure an exceptionally efficient service on the routes by which international traffic of exceptional importance passes.

Article 7.

In the event of international traffic being temporarily suspended or restricted on a given route, the administrations working lines on that route, in so far as it is within their province to take remedial measures, shall endeavour to re-establish a normal service as soon as possible, and, in the meantime, to send the traffic by another route, if necessary with the aid of the administrations of other States which may be in a position to give assistance over their systems.

Article 8.

The Contracting States shall so regulate their Customs and police formalities as to subject international traffic to the least possible hindrance and delay. The same obligation shall apply to passport formalities in so far as such are required.

The Contracting States shall specially encourage measures calculated to restrict the formalities at frontier stations, and particularly agreements concerning the fastening of wagons and the sealing of baggage passing through under Customs control, and also arrangements allowing Customs formalities to be carried out in the interior of a country.

PART II

Reciprocity in the use of rolling-stock : Technical uniformity.

Article 9.

So far as circumstances reasonably permit, the Contracting States shall urge the railway administrations under their sovereignty or authority, whose lines form a continuous system of the same gauge, to enter into agreements with each other providing for all such measures as are calculated to allow or facilitate the exchange and reciprocal use of rolling-stock.

Such agreements may also provide for giving assistance by the supply of empty wagons in cases where such assistance is necessary to meet the needs of international traffic.

Measures which would entail modifications in the essential characteristics of a railway system or rolling-stock are not included among the measures to be dealt with in the abovementioned agreements.

Nevertheless, in cases where such modifications appear specially desirable owing to the intensity of the traffic and the comparatively small extent of the adaptation required, the Contracting States concerned agree to communicate to each other without delay any proposal as to such modifications and to examine such proposals together in a friendly spirit.

Article 10.

With a view to facilitating the reciprocal use of rolling-stock, the Contracting States shall facilitate the conclusion of agreements for technical uniformity of railways, particularly in respect of the construction and maintenance of rolling-stock, and the loading of wagons, in so far as such agreements may be advantageous for the proper carriage of international traffic.

With a view to affording international traffic all the facilities and security desirable, such agreements may, particularly in the case of groups of contiguous countries, provide for the standardisation of conditions of construction and of railway equipment of a technical nature.

Article 11.

Special agreements may also provide for assistance by the supply of locomotives and, should the international traffic concerned justify it, by the supply of fuel or electric power.

Article 12.

Special agreements between States may provide that the rolling-stock of any administration, including locomotives and all movable property forming part of and contained in such rolling-stock, shall be immune from seizure on the territory of a State other than that to which the owning administration belongs, except in virtue of a judgment of the courts of the latter State.

Article 13.

The use and the circulation in international traffic of wagons of private persons, or organisations other than railway administrations, shall be dealt with by special agreements.

PART III.

Relations between the railway and its users.

Article 14.

In the interests of international traffic, the Contracting States shall, so far as circumstances reasonably permit, facilitate the conclusion of agreements permitting the use of a single contract to cover an entire journey; in such agreements an effort will be made to attain the greatest possible measure of uniformity in the conditions governing the execution of

the through contract by each of the various administrations taking part in the carrying of the traffic.

Article 15.

Failing a single transport contract, reasonable facilities shall be afforded for the carriage on successive contracts of traffic passing over the railways of two or more Contracting States.

Article 16.

The principal matters to be dealt with by the special agreements relating to the single transport contract for passengers and baggage are the following :

a) The conditions under which the railway is obliged to accept, or is at liberty to reject, the transport contract;

b) The conditions governing the conclusion of the transport contract and the drawing up of the document containing the terms of the contract;

c) The obligations and regulations with which the passenger is obliged to comply;

d) The passenger's obligations as regards the compliance with other formalities (such as Customs formalities) connected with the journey and necessary for its completion;

e) The conditions of delivery of baggage;

f) The provisions applicable in the case of interruption of service or other hindrances to the completion of the journey;

g) The responsibility assumed by the railways under the transport contract;

h) Rights of action arising out of the transport contract and the enforcement of judgments.

Article 17.

The principal matters to be dealt with by the special agreements relating to the single transport contract for goods are the following :

a) The conditions under which the railway is obliged to accept, or is at liberty to reject, the transport contract;

b) The conditions governing the conclusion of the transport contract and the drawing up of the document containing the terms of the contract;

c) Definition of the obligations and responsibilities of the various parties concerned in the contract concluded with the railway;

d) Provisions relating to the route to be followed and to the time-limit, if any, whithin which the transport should be completed;

e) The conditions regulating compliance during the journey with other formalities (such as Customs formalities) connected with and necessary for the carriage of the goods;

f) The conditions governing the delivery of the goods, and the conditions of payment of the railway charges;

g) The guarantees given to the railway for the payment of its charges;

h) The measures to be taken in case of obstacles preventing carriage or delivery;

i) The responsibility assumed by the railway under the transport contract;

j) Rights of action arising out of the transport contract and the enforcement of judgments.

PART IV.

Tariffs.

Article 18.

The tariffs in force in accordance with national laws and duly published before coming into force shall fix :

In respect of passengers and baggage, the rates for carriage, including incidental charges, if any, and the conditions under which they shall be applied;

In respect of goods, the rates for carriage, including incidental charges, the classification of goods to which these rates are applicable and the conditions

to which such application shall be subject.

The railways shall be obliged to grant to any traffic the tariff applicable to it, provided that the traffic fulfils the conditions of the tariff.

Article 19.

As regards international traffic, the railways may not levy, over and above the charges fixed in the tariffs applicable to any particular traffic, any charges other than those which constitute an equitable remuneration for services which are not covered by the charges fixed in the tariffs.

Article 20.

The Contracting States, recognising the necessity in general of leaving tariffs sufficient flexibility to permit of their being adapted as closely as possible to the complex needs of trade and commercial competition, retain full freedom to frame their tariffs in accordance with the principles accepted by their own legislation, provided that this freedom is exercised without detriment to international traffic.

They undertake to apply of international traffic tariffs which are reasonable both as regards their amounts and the conditions of their application, and undertake to refrain from all discrimination of an unfair nature directed against the other Contracting States, their nationals or their vessels.

These provisions shall not prevent the establishment of combined rail and sea tariffs which comply with the principles laid down in the previous paragraphs.

Article 21.

The benefit of the provisions of Article 20 shall not be confined to transport based on single contracts. It shall extend equally to transport made up of successive stages by rail, by sea or by any other mode of transport traversing the territory of more than one Contracting State and regulated by separate contracts, subject to the fulfilment of the following conditions :

Each of the successive contracts must specify the initial source and final destination of the consignment; during the whole duration of carriage the goods must remain under the supervision of the carriers and must be forwarded by each carrier to his successor direct and without delay other than that necessary for the completion of the transport operations and the customs, octroi, police or other administrative formalities.

Article 22.

The provisions of Article 20 shall be equally applicable to internal, as well as to international, traffic by rail as regards goods which remain temporarily at the port without regard to the flag under which they have been imported or will be exported.

Article 23.

The Contracting States shall endeavour to promote the establishment of international tariffs to meet all the needs of international traffic which they can reasonably satisfy. They shall also facilitate the adoption of all measures tending, even apart from international tariffs, to make possible the ready calculation of the transport charges as regards the more important movements of traffic.

Article 24.

The Contracting States shall endeavour to obtain uniformity in the mode of presentation of both international and national tariffs, particularly in respect of groups of contiguous territories, with a view to facilitating the application of such tariffs in respect of international traffic.

PART V.

Financial arrangements between railway administrations in the interest of international traffic.

Article 25.

The financial arrangements between railway administrations shall be such as not to hamper the working of international traffic and particularly the application of single transport contracts.

Article 26.

As regards railway receipts, the matters to be dealt with by these arrangements are, more particularly, the following :

a) Regulations respecting the right of each administration to receive its share of the sums due to the railways;

b) Regulations respecting the responsibility of an administration which fails to collect a sum for the collection of which it is responsible;

c) Arrangements to be made to ensure the accuracy of accounts where administrations entrust such accountancy work to other administrations;

d) Arrangements for reducing, so far as circumstances permit, the actual transfer of funds necessitated by financial settlements between administrations.

Article 27.

As regards sums which a railway has paid to its users, the matters to be dealt with in arrangements between railway administrations are, more particularly, the following :

a) Regulations regarding the right of recourse of an administration which has paid compensation against other administrations taking part in the carriage;

b) Provisions determining the responsibilities of the different administrations or the responsibilities which they agree to share;

c) Provisions dealing with the recourse of administrations against each other in the case of one of them deciding to refund a sum levied in excess of the amount due to the railway (overcharge);

d) Rules as to the recognition by the administrations of a judgment which has been given against one of them obliging it to make a payment.

Article 28.

Where, as the result of the state of the exchanges, difficulties arise constituting a serious hindrance to international traffic, measures shall be taken to reduce such inconveniences to a minimum.

Any railway administration which is subject to the risk of appreciable loss on currency exchange in the settlement of accounts may protect itself by adding to its through transport charges such a premium as may be reasonably sufficient to cover such risk. The arrangements between the railway administrations may provide for fixed rates of exchange subject to periodical revision.

Measures shall be taken to prevent as far as possible any improper speculations being made by intermediaries in the course of the transactions necessitated by the state of the exchanges.

PART VI.

General Regulations.

Article 29.

Measures of a general or particular character which a Contracting State is obliged to take in case of an emergency affecting the safety of the State or the vital interests of the country may, in exceptional cases, and for as short a period as possible, involve a deviation from the provisions of the above articles,

it being understood that the principles of the present Statute must be observed to the utmost possible extent.

Article 30.

No Contracting State shall be bound by this Statute to ensure the transit of passengers whose admission into its territories is forbidden, or of goods of a kind of which the importation is prohibited, either on grounds of public health or security or as a precaution against diseases of animals or plants. As regards traffic other than traffic in transit, no Contracting State shall be bound by this Statute to ensure the transport of passengers whose admission to its territory is prohibited, or of goods of which the import or export is prohibited by its national laws.

Each Contracting State shall be entitled to take the necessary precautionary measures in respect of the transport of dangerous goods or goods of a similar character, it being understood that such measures must not result in any discrimination contrary to the principles of the present Statute, and also to enforce general police measures, including police measures in connection with emigration traffic.

Nothing in this Statute shall affect the measures which one of the Contracting States is or may feel called upon to take in pursuance of general international conventions to which it is a party, or which may be concluded hereafter, particularly conventions concluded under the auspices of the League of Nations, relating to the transit, export or import of particular kinds of articles such as opium or other dangerous drugs, arms, or the produce of fisheries, or in pursuance of general conventions intended to prevent any infringement of industrial, literary or artistic property, or relating to false marks, false indications of origin or other methods of unfair competition.

Article 31.

The provisions of this Statute do not of themselves impose on any Contracting States any new obligation to facilitate the transport of nationals of a non-contracting State, or their baggage, or of goods, carriages, or wagons coming from or destined to a non-contracting State.

Article 32.

This Statute does not prescribe the rights and duties of belligerents and neutrals in time of war. The Statute shall, however, continue in force in time of war so far as such rights and duties permit.

Article 33.

This Statute does not entail in any way the withdrawal of facilities which are greater than those provided for in the Statute and which have been granted to international traffic by rail under conditions consistent with its principles. This Statute also entails no prohibition of such grant of greater facilities in the future.

Article 34.

In conformity with Article 23 (*e*) of the Covenant of the League of Nations, any Contracting State which can establish a good case against the application of any provision of this Statute, in part or all of its territory, on the ground of the grave economic situation arising out of the acts of devastation perpetrated on its soil during the war 1914-1918, shall be deemed to be relieved temporarily of the obligations arising from the application of such provision, it being understood that the principles of this Statute must be observed to the utmost possible extent.

Article 35.

Should a dispute arise between two or more Contracting States as to the inter-

pretation or the application of the present Statute, and should it prove impossible to settle such dispute either directly between the Parties or by any other method of amicable settlement the Parties to the dispute may, before resorting to any procedure of arbitration or to a judicial settlement, submit the dispute for an advisory opinion to the body established by the League of Nations as the advisory and technical organisation of Members of the League for matters of communications and transit. In urgent cases, a preliminary opinion may be given recommending temporary measures, including measures to restore the facilities for international traffic which existed before the act or occurrence which gave rise to the dispute.

Should it prove impossible to settle the dispute by any of the methods of procedure enumerated in the preceding paragraph, the Contracting States shall submit their dispute to arbitration unless they have decided, or shall decide, under an agreement between them, to bring it before the Permanent Court of International Justice.

Article 36.

If the case is submitted to the Permanent Court of International Justice, it shall be heard and determined under the conditions laid down in Article 27 of the Statute of the Court.

If arbitration is resorted to, and unless the Parties decide otherwise, each Party shall appoint an arbitrator, and a third member of the arbitral tribunal shall be elected by the arbitrators, or, in case the latter are unable to agree, shall be selected by the Council of the League of Nations from the list of assessors for communications and transit cases mentioned in Article 27 of the Statute of the Permanent Court of International Justice; in such latter case the third arbitrator shall be selected in accordance with the provisions of the penultimate paragraph of Article 4 and the first paragraph of Article 5 of the Covenant of the League.

The arbitral tribunal shall judge the case on the basis of the terms of reference mutually agreed upon between the Parties. If the Parties have failed to reach an agreement, the arbitral tribunal acting unanimously shall itself draw up terms of reference after considering the claims formulated by the Parties; if unanimity cannot be obtained, the Council of the League of Nations shall decide the terms of reference under the conditions laid down in the preceding paragraph. If the procedure is not determined by the terms of reference, it shall be settled by the arbitral tribunal.

During the course of the arbitration the Parties, in the absence of any contrary provision in the terms of reference, are bound to submit to the Permanent Court of International Justice any question of international law or question as to the legal meaning of this Statute the solution of which the arbitral tribunal, at the request of one of the Parties, pronounces to be a necessary preliminary to the settlement of the dispute.

Article 37.

The Contracting States shall facilitate the conclusion of special agreements for the purpose of putting the provisions of the present Statute into force in cases where existing agreements are not adequate for this purpose.

Article 38.

The provisions of this present Statute may be extended by special conventions to transport undertakings operating means of transport other than railways, particularly where such undertakings are ancillary to railway transport.

Such undertakings shall thereupon be subject to all the obligations imposed and shall be entitled to all the rights conferred upon railways by the present Statute.

Nevertheless, the special conventions referred to in paragraph 1 may allow of any exceptions to the present Statute which may be necessary owing to the difference in the methods of transport. In particular, in the case of contracts relating to international traffic carried partly by rail and partly by sea, such exceptions may provide for the application of maritime law of the sea journey.

Article 39.

Should special conventions as provided for in Article 38 not be applicable, reasonable facilities shall be afforded for the movement of traffic by rail and a different means of transport, such as transport by sea.

Article 40.

The Contracting States undertake to introduce into those existing conventions which contravene the provisions of this Statute, so soon as circumstances permit and in any case on the expiry of such conventions, the modifications required to bring them into harmony with such provisions, so far as the geographical, economic or technical circumstances of the countries or areas concerned allow.

Article 41.

Without prejudice to the application of Article 24 of the Covenant of the League of Nations, all offices or bureaux which have been, or may be, set up by international conventions to facilitate the settlement between States of questions concerning transport by rail shall be regarded as animated by the same spirit as the organisations of the League of Nations, and — for the purposes of the execution of the present Statute — as extending, within their particular sphere, the action of these organisations; they will therefore exchange with the competent organisations of the League all relevant information concerning the fulfilment of their function of international co-operation.

Article 42.

The Contracting States shall take all necessary steps to communicate to the League of Nations all information likely to assist the organisations of the League in carrying out the tasks which fall to them with a view to the application of the present Convention.

Article 43.

It is understood that this Statute must not be interpreted as regulating in any way rights and obligations *inter se* of territories forming part of or placed under the protection of the same sovereign State, whether or not these territories are individually Contracting States.

Article 44.

Nothing in the preceding Articles is to be construed as affecting in any way the rights or duties of a Contracting State as Member of the League of Nations.

[625 .112 (.3)]

RAILWAY GAUGES. (1)

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Figs. 1 to 10, pp. 37 to 61.

PREFACE

I

It may be considered strange that one should at the present day re-open the discussion on railway gauges, since it would appear that this was settled long ago. The reason is that the gauge problem arises in a number of cases.

In a number of newly developed countries and colonies, railways are only beginning to be constructed, and lines have to be built which run through vast tracks of country which are as yet almost unexplored. It is obvious that the question of the most suitable gauge has to be considered.

In older countries, the railway system has been developed, but it is necessary to supplement the existing railways by secondary lines, and the same question arises.

Also, for reasons which we will examine later, there may be two gauges existing in the same country. If it is intended to build a new line, it is necessary to decide which of the gauges is to be adopted. This is the case for instance in the Argentine and in Brazil.

In other countries where different gauges are in use, the question of standardisation may arise, and it is then necessary to study the question from this special point of view. This is the case in Australia and British India.

In some cases the existing gauge may have reached its maximum carrying capacity, as in Japan, and it must be decided whether a change should be made or whether double track should be laid.

Finally, there are cases, as in Spain, where it is desirable to facilitate interchange of traffic with neighbouring countries in which the gauge is different and where in such cases the conversion of the existing gauge is contemplated.

We have here examples of cases in

(1) Translated from the French.

which the gauge question should be re-examined, and for different reasons in each case.

We may add that it is necessary to study the question of gauges, because information on the subject is somewhat limited, and if one applies in any particular country in too rigid a manner the results of experience gained elsewhere one runs the risk of adopting solutions which may, to say the least, be debatable.

For these reasons it may be well to re-examine this subject.

II

The question of gauges should be considered in the light of the following considerations which we regard as axioms :

1. — It is necessary to take great care in this case, as in other matters, that conclusions should not be drawn from faulty comparisons. When one compares two things, whatever they may be, it is necessary to carry out the comparison under conditions which are identical. In other words, one must not, in making direct comparison between standard gauge lines and narrow gauge lines, lay stress on the point that one may obtain higher speeds and use heavier railway stock on the former, and for this reason overlook all the advantages of the narrower gauge. A comparison of this kind is useless and leads to nowhere.

2. — One must distinguish between main lines and secondary lines. A narrow gauge line may be one or the other of these, while the same is true of the standard gauge.

3. — Undue stress should not be laid to the inconvenience which results from reloading at interconnecting stations. This inconvenience is considerable, but consideration must be given to the total passenger and goods transport carried on both gauges and to the utilisation of rolling stock.

4. — From the point of view of cost, both as regards construction and operation, one must not take two examples, whatever they may be, and compare the one with the other without at the same time making sure that all the factors concerned are identical.

5. — The number of gauges should be reduced to the minimum possible, but this should not be obtained regardless of cost, and certainly not if it is uneconomical. Railways are but a means of transport, and are not an end in themselves.

We shall see later in the article that it is necessary to insist on these various points, which, worded as they are, may perhaps appear self evident.

III

We will divide our discussion into three parts.

In the first part, chapters I to VII will contain general remarks on the question of gauge.

Chapters VIII and IX will deal with reloading at connecting stations. It may be well to discuss these two chapters at length, as they contain information which is particularly useful, giving as they do the advantages and disadvantages of reloading at stations where lines of different gauges meet.

Chapters X to XIX deal with gauge conversions. Here again we shall give a large amount of information, because, together with the question of reloading, this problem is one which very frequently presents itself.

DEFINITIONS. — In order that we may save unnecessary explanations in the text, we mean by « **Gauge** » or « **Gauge of a railway** », *the distance between the internal faces of the heads of the rails on straight portions of the track.* It is recognised that this definition is not always rigidly applied, but its use, as will be seen by consulting the technical press and railway text books, has been very generally adopted in practice.

It has been suggested that the expression *Width of the track* should be used. It appears to us to be not so exact as the foregoing expression, because it may be equally well applied to the width of the formation as to the rails themselves. If the term is restricted to a pair of rails, it is necessary to state whether the width is taken from centre to centre of the rails, or between their inner faces. Its use in the early days of railway construction, to indicate the distance between the longitudinal axes of the rails, gave rise to variations in the gauge, because the width of the heads was not the same in all types, and it was therefore wisely abandoned. Where we employ the term « breadth of the track », we mean by this the distance between the internal faces of the heads of the rails.

By **Standard gauge** is meant the gauge which is chiefly used (1 m. 435 or 4′ 8 1/2″).

Broad gauges are those in which the distance between the rails is greater than in the standard gauge. In practice these gauges are from 1 m. 52 (5′) upwards (1).

By **metre gauge** is meant (2), gauges which are approximately 1 m. (3′ 3 3/8″). The actual gauge in these cases varies from 0 m. 95 to 1 m. 05 or 1 m. 067 (from 3′ 1 3/8″ to 3′ 5 3/8″ or 3′ 6″).

By **Narrow gauge** we mean (3), gauges of 0 m. 75 (2′ 5 1/2″) and under.

METRIC MEASUREMENTS AND ENGLISH MEASUREMENTS. — Finally, as it is often necessary to compare our dimensions with those of British and American railways, we shall give these measurements in both systems. We have retained the English convention which indicates a foot by one stroke (′), and the inch by two strokes (″), so as to avoid useless repetitions of the words *feet* and *inches*.

We have also retained the symbol *lb.* to indicate the English pound and to distinguish it from ours.

(1) The term *Broad gauge* is used as opposite to the *Standard gauge* in all countries where lines of this gauge are employed.

(2) We have introduced the term *Metre gauge* which appeared in a former article in the *Annals of Public Works* of 20 years ago, in order to designate railways which had a gauge of about 1 m.

(3) The term *Narrow gauge* is used in the Argentine for the *Metre gauge* as opposed to the *Standard gauge* of 1 m. 435. In this article it is applied to railways which have a gauge less than one *Metre*.

PART I.

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CHAPTER I. — GENERAL CONSIDERATIONS.

It is an extraordinary fact, that in the early days of railways, the gauge, that is to say, the width of the track, was not in the majority of cases definitely chosen, but this very important matter has been in nearly every case determined by chance. This was the case in the early days of English railways, as it was also in the case of the Argentine broad gauge and the Algerian of 1 m. 05 (3′ 5 3/8″), etc.

As a matter of fact, all that was done was to adopt the width of track of the ordinary road vehicles of the period, a distance which dates back to very early times. These were worked by the only motive power then available, the horse, who has hardly changed throughout the centuries, and the distance between the wheels of the Roman chariot found at Pompeii is almost identical with that of vehicles of the present day. When the locomotive, however, came into existence, there were so many other points to be settled, that the question of gauge was overlooked, and the gauge of 1 m. 50 (4′ 11″) from centre to centre of the rails was adopted, without any definitive reason for doing so.

It is true that Brunel, the brilliant engineer of the *Great Western Railway*, adopted the broad gauge of 7′ (2 m. 13) between the rails. His line was certainly

superior, both as regards capacity and stability, and if at that time a distinction had been made between main lines and secondary lines, it is possible that the gauge of 1 m. 435 would not have been universally adopted. In 1845, when the standardisation of gauges was decided upon in England, the gauge of 1 m. 435 satisfied the requirements; the broad gauge appeared to be unnecessary, and nobody, with the exception of Brunel, foresaw the extraordinary development which would take place in railway transport.

In making a complete review, mention should be made of the little Festiniog Railway, which was opened in 1839, and which, in spite of its narrow gauge of 0 m. 60 (1′ 11 5/8″), has given very good service. In this case, however, we have merely a satisfactory solution of an exceptional case, and before further discussion, it is necessary to draw a distinction between main lines and secondary lines.

The great mistake that was made in the first place is obvious. Everybody selected a gauge in accordance with their own ideas. The remedy laid in standardisation, and this was done without much consideration.

We have given this historical sketch, because we have come to a period when the gauge question may be discussed with advantage, both as regards the lines to be constructed and also for existing lines, on some of which an unnecessary number of different gauges are used, while others lay narrow gauge lines which should be standard gauge lines, or *vice versa*.

CHAPTER II. — GAUGE OF MAIN LINES.

It is obvious that a number of different gauges may be equally suitable, but that it is important to reduce the number to a minimum so that rolling stock may be interchangeable between the various railway systems.

There is also another advantage to be obtained, namely, that there is a growing tendency towards standardisation of components which facilitates ordering and manufacture. Thus it is bad practice to employ side by side, as is done in Algeria, gauges of 1 m. and 1 m. 05 (3′ 3 3/8″ and 3′ 5 3/8″), or in Switzerland 0 m. 89 and 0 m. 91 (2′ 11″ and 3′). The best gauge to be adopted may not perhaps be the same in every case, because economical conditions vary in different countries, and each gauge has its own advantages, and it is therefore necessary to chose that which may be best adapted to the country concerned. It is indisputable that it is necessary to use the « standard » gauge in all countries where this predominates. Although, however, it may be advisable to use a broad gauge in the more developed portions of overseas countries or in districts where sufficiently heavy traffic is anticipated in the near future, it is a question which should be carefully looked into whether one may not at the outset use a narrower gauge for outlying districts. In this way, a saving in first cost may be obtained, which has to be set off against the increased operating cost which may result therefrom. Thus, when the country has become sufficiently developed, one may

extend the broad gauge further into the interior so as to gradually substitute it for the narrow gauge.

Moreover, it is often difficult to finance enterprises of this kind, and the available money should be utilised in the first place to construct as large mileage as possible on the understanding that the gauge should be altered later when receipts warrant this and the traffic makes it necessary.

In this way it was sound practice to build the lines radiating from Buenos-Ayres into the neighbouring fertile plain with the broad gauge, and to extend them as it was found necessary to do so, and it was also sound to build the outlying lines which extend into the Cordillera with the 1 m. gauge. There was, however, no justification in the reverse process of carrying the latter as far as Buenos-Ayres. As a matter of fact, the district is a very fertile one, and one should have anticipated the considerable agricultural traffic for which large rolling stock was most suitable. Moreover, as the earthworks were almost nil, the difference in the cost of construction was relatively small, and it was absurd to limit in this way the capacity of the new lines.

In Peru, mountain railways were constructed which, leaving the sea coast, traversed a mountainous region up to the summit of the Andes at more than 4 000 m. (13 000 feet) altitude. These had curves and reverse curves of very small radius and were constructed to the standard gauge. Bearing in mind the moderate traffic, narrow gauge lines would have been sufficient, not only for the present time, but probably for another 20 years. They would have allowed a considerable saving in the cost of construction, and probably a saving in the very heavy operating expenses of the standard gauge lines with very sharp curves.

For mountain lines, the standard gauge can only be justified where there is reason to anticipate a fairly important traffic in the near future, but it is justifiable when the line through the mountains connects two systems of this gauge and deals with an important through traffic, as in the case of the *Transalpine railways*. If, in contradiction of the rule, the *Transandine Railway* had been constructed to the metre gauge, although it connects the broad gauge systems of the Argentine and Chili, seeing that it is for the most part used for passenger traffic, and therefore the question of transshipment is of small importance; the saving in the cost of construction would no doubt have been very great.

The 1 m. gauge has been very largely used for mountain lines, even in the case of main lines, and this is still being done with the object of the saving in cost of construction by a reduction of gauge. The mountain line of the *Denver and Rio Grande Railway* in the United States was constructed to a 3′ (0 m. 91) gauge, and was subsequently converted to standard gauge in view of the increase of traffic, but this does not imply that the Company were at fault in selecting the narrow gauge to open up and develop the country. The same applies to the main line of the *Antofagasta and Bolivia Railway*, which has a length of 687 km. (427 miles) as far as Ollagüe, which was built to the 2′ 6″ (0 m. 76) gauge, and which successfully carried all the traffic required. It was not till it had been opened some years that the Company began to convert the track to 1 m., as was found necessary. The same gauge of 0 m. 76 is used on the mountain system of *Bosnia-Herzegovina* and in a number of other cases.

Finally, temporary or military railways are often laid to the gauge of 0 m. 60 so that these can be abandoned when they are no longer required, or relaid from other bases if this is found necessary.

It is therefore sound practice to use a narrow gauge, which is laid, not as a secondary line, but as a main line in the case of railways for opening up countries which will not have a considerable traffic until a number of years have elapsed, and to keep the broad gauge for lines which carry or are capable of carrying a traffic proportional to their greater capacity.

CHAPTER III. — GAUGE OF SECONDARY LINES.

We will define by secondary lines, lines carrying a light traffic which serve as feeders to the more important lines and which complete the railway system.

The first problem which presents itself in their construction is the following : Is it necessary to lay these lines to the same gauge as those of the principal lines, although with less rigorous structural conditions, or should a more economical gauge be chosen?

The question is a very old one and has not yet been definitely solved. In 1861, a French Commission of enquiry decided upon the adoption of a narrower gauge for secondary lines, and in 1865 a meeting of German engineers at Dresden arrived at conclusions which were absolutely the reverse of this, namely, that the same gauge should be used for lines of both categories.

We will now proceed to the discussion of the various possible solutions :

1. **With the same gauge and the same structural conditions.** — A line built under these conditions will be as costly to build as a main line. If it has an equal traffic, it is no longer a secondary line, but otherwise it will be worked at a loss. This solution therefore is only permissible for branch lines on which the traffic ought to develop still further, or where the traffic will run a sufficient distance on the remainder of the system to allow the loss on the first portion to be regained.

2. **With the same gauge but with different structural conditions.** — One may adopt for secondary lines steeper gradients, sharper curves and a lighter superstructure. This solution has many supporters, as it allows — theoretically — the use of the same rolling stock on the main lines and on the secondary lines. Actually this is only partially true, and only some of the rolling stock can be thus utilised. It is true that this can be done, provided the speed is reduced, though this is an unsatisfactory restriction.

It is obvious that a secondary line laid to the same gauge as the main line costs more than a narrow gauge. It therefore seems that this solution should only be adopted under the following conditions :

a) If the system possesses only a few secondary lines, and finds, that in spite of the increase of cost, that it thus avoids the complication of the relatively small amount of track laid at a different gauge;

b) If the main line passes in proxi-

mity to a locality of a certain importance and can avoid going out of its course by the use of a branch line constructed under similar conditions on which a shuttle service is run;

c) If the secondary line connects a station on the main line from which a traffic is despatched which it is not convenient to transship, on account of transport cost being increased thereby, in cases where the goods are easily deteriorated or where they are perishable (1).

It is often said that having main lines and secondary lines of the same gauge allows the latter to be easily converted into main lines whenever the traffic justifies it. Too much should not be made of this, for one is obliged in the case of the secondary line to construct this in a less thorough manner than a main line, or otherwise the construction is unnecessarily costly. For this reason, the conversion will often for practical purposes be a reconstruction. If the final transformation from a secondary line to a main line can be cheaply carried out, a main line would have probably been built in the first place. If the necessary work is considerable, one may content oneself with carrying out the less important of these, retaining, for example, some steep gradients, which compromise has been adopted in certain cases.

3. **With a narrower gauge for secondary lines.** — Essentially the secondary line should be cheaper because it is more difficult to pay an interest on its capital outlay. For this reason the latter should be as small as possible, provided that operation is not too much handicapped thereby.

It is necessary to arrive at a compromise in this case. One should eliminate all costly works, especially bridges, tunnels, etc., reduce the amount of earthwork and lighten the superstructure and rolling stock. Under these conditions the lines should be altogether less costly as the gauge becomes narrower. It is for this reason that the third solution is the one which is very generally adopted.

It may be well to state here the conclusions which were arrived at on the subject at the *International Union of Tramways and Light Railways* at the Congress held at Amsterdam in 1890 :

> Narrow gauge should be adopted, except in special cases, such as where one is dealing with a line of short length which joins the main line, but which carries an important goods traffic

The meeting held at Hamburg in 1891 agreed that the adoption of the narrow gauge led to economy in construction and operation. The same was the case at Budapest in 1893, etc., as well as in the conclusions of the International Railway Congress at Brussels in 1885, Milan in 1887, St. Petersburg in 1892, etc.

As an example, we give (table 1) the gauge which is in use for the various categories of main lines, secondary and light railways.

By *light railways* we mean short lines which are constructed in cases where it is necessary to have a railway, and where it will be some time before there is a paying traffic. In this case one sacrifices all other considerations to that of economy, both as regards construction and operation.

(1) This is a case for example of the *National Light Railways of Belgium* as regards the lines from *Groenendael to Overijssche*, which for the main part carry fruit and vegetables, and the line from *Poulseur to Sprimont*, which serves quarries; both of these are laid to the standard gauge, as are the State Railways, instead of to the metre gauge of the above Light Railways Company.

TABLE 1.

Gauges adopted for main lines and secondary lines in new countries.

COUNTRY.	Districts		Secondary lines	Light railways.
	already developed.	to be developed.		
Argentine	1 m. 676	1 m.	0 m. 60 to 1 m. 067	0 m. 60 to 1 m.
Brazil	1 m. 600	1 m.	1 m.	0 m. 60 to 0 m. 75
Chili	1 m. 676	1 m.	1 m.	0 m. 60
Peru	1 m. 435	0 m. 914	0 m. 914	0 m. 60 to 0 m. 914
Uruguay	1 m. 435	Not yet determined.	Not yet determined.	Not yet determined.
Paraguay	1 m. 435	1 m.	Not yet determined.	Not yet determined.
Mexico	1 m. 435	0 m. 914	0 m. 914	0 m. 60
Egypt	1 m. 435	0 m. 61	0 m. 750	...
British India	1 m. 676	1 m.	1 m. and 0 m. 76	0 m. 76 and 0 m. 61
New South Wales	1 m. 435	...	1 m. 067	...
Southern Australia	1 m. 600	1 m. 067	...	0 m. 61
Western Australia	1 m. 067	1 m. 067	...	...
Tasmania	1 m. 067	...	0 m. 610	...
China	1 m. 435	...	1 m.	...
Asia Minor	1 m. 435	1 m. to 1 m. 05	...	...

CHAPTER IV. — DIFFERENT GAUGES IN THE SAME COUNTRY.

In spite of the inconveniences which result from a diversity of gauges, there are hardly any countries in which various gauges do not exist.

As a rule, the 1 m. 435 gauge is adopted, or in certain countries a broad gauge (1), and the system is completed by a secondary system which is generally laid to narrow gauge. However, the distinction between the two categories of lines is often incomplete, as it is difficult to lay down hard and fast rules in every case, for two classes of railways. Moreover, in the mountain valleys, lines have been constructed to a narrower gauge than that of the general railway system, even in the case of Europe.

This is so in Switzerland in the case of the Grisons line (*Rhaetian, Furka* and *Bernina Railways*, which are all of the

(1) See definition given above.

metre gauge). This is also the case in Bosnia where a number of Jugo-Slavian railways are laid at a gauge of 0 m. 75, and of a whole series of lines laid with the metre gauge on the slopes of the Pyrenees (*Cantabrian, Asturian Railways*, etc.), although the Spanish system is 1 m. 676 (5′ 6″) gauge.

An exception occurs in the case of the Russian Empire, which has constructed its railways to the 1 m. 52 gauge. The new division of Europe has detached certain provinces which have been annexed by other countries which use the 1 m. 435 gauge, and who have therefore two gauges for their main lines. Roumania is an example of this.

In new countries and in the majority of countries overseas, the most urgently required railways have been constructed independently of each other, whether these are lines connecting an interior town with a port, or connecting two important centres, or putting these into communication with a navigable waterway. There is therefore no co-ordination between these railways which are a long distance one from the other, each of which may become the nucleus of the systems which may be developed in the future. If they have been laid with the same gauge, it is a fortunate coincidence, but such a case is rare, and it is this that explains the multiplicity of gauges which one meets with in certain countries. Thus, in Brazil, in addition to the two principal gauges of 1 m. 60 and 1 m. (5′ 3″ and 3′ 3 3/8″), there are small lines constructed to various different gauges, and in Chili, in addition to the railways of 1 m. 60 or 1 m. gauge, there are no less than eight others.

On the other hand, it is often sound practice to adopt two different gauges for the main lines in new countries. In fact one may always distinguish between two districts, one of which is populated and comparatively advanced, while the other has yet to be developed. The economic conditions are totally different, hence as a rule one generally uses a larger gauge for the former than for the latter, as is shown in the following examples :

Argentine	1 m. 67 and 1 m. 435.	1 m.
Brazil (Central States) .	1 m. 60.	1 m.
Chili	1 m. 67.	1 m.
British India	1 m. 67.	1 m.
Southern Australia . .	5′ 3″ (1 m. 60).	3′ 6″ (1 m. 067).

However, this is not always the case, and in certain countries which are less advanced and where the original railways have been laid to the narrow gauge for the sake of economy, this has been used for later extensions. This is the case in Bolivia, in a large part of Brazil, and in the majority of the colonies.

Certain countries have laid down general technical conditions for each of the gauges they employ, which are therefore *the* standard gauges of the country under consideration.

Thus, in Chili, lines are divided into three categories according to their importance in the general scheme. Table 2 gives the principal characteristics of each of these three categories of each of the three gauges included in the system.

On the other hand, although there may be good reasons for employing several gauges in the same country, this should be done with caution. In British India, where gauges of 1 m. 676 and of 1 m. are in use, the Commission appointed in 1885 decided to define the districts in which each of these were to be used. These have not been adhered to, and the two systems at the present time are intermixed exactly as they are in the Argentine.

TABLE 2.

Characteristics of lines of different gauges of the Chilian State Railways.

Gauge		1 m. 676	1 m.	0 m. 60
First category :	Maximum gradients	1 °/₀	2.5 °/₀	3.5 °/₀
	Minimum radius	300 m.	150 m.	80 m.
	Minimum straight (1)	100 m.	60 m.	50 m.
Second category :	Maximum gradients	2 °/₀	3 °/₀	4 °/₀
	Minimum radius	200 m.	100 m.	60 m.
	Minimum straight	60 m.	40 m.	20 m.
Third category :	Maximum gradients	2.5 °/₀	3.5 °/₀	4.5 °/₀
	Minimum radius	180 m.	80 m.	40 m.
	Minimum straight	40 m.	20 m.	10 m.

(1) Length of straight track between curves in opposite directions.

In India, one has even gone further than this, and has constructed still cheaper lines of a narrower gauge of 2′ 6″ and 2′ (0 m. 76 and 0 m. 61). Three gauges in India, as in the Argentine (1 m. 676, 1 m. 435 and 1 m. [5′ 6″, 4′ 8 1/2″ and 3′ 3 3/8″]) appear to be unnecessary. We should be inclined to standardise the gauges in accordance with the two extreme gauges : 5′ 6″ and 2′ 6″, or 1 m. in India; 1 m. 676 and 1 m. in the Argentine. At the present time the gauges of 1 m. and 2′ 6″ on the one hand, and those of 1 m. 676 or 1 m. 435 on the other hand are often both used. We will return to this subject later.

The rules laid down on this point some little time ago by R. W. Gillan, President of the *Railway Board*, gave a clear statement on the matter; their truth is obvious, but nevertheless they have often been disregarded. They are as follows :

1. — Railways may be divided into two classes, main lines and branch lines, or feeders.

2. — For main lines, the broad gauge is more satisfactory than the metre gauge, and continuity of gauge is a matter of importance.

3. — When a new line is to be built in a country in which the metre gauge is not in general use, it should devolve upon the latter to prove its superiority as compared with the broad gauge for the new line under consideration.

If the limit of capacity of a single line of 1 m. situated at no great distance from a broad gauge system has been reached, it may be assumed that it is better to increase the metre gauge or to construct an alternative broad gauge line than to lay a double line of 1 m. gauge.

4. — It is not necessary to attempt to connect by means of the metre gauge, separate systems laid to this gauge.

5. — In the case of branch lines, or feeders, the continuity of gauge is less important. Moreover, it must be remembered that the establishment of a break of gauge is not an advisable method of avoiding competition with the main lines.

6. — One should aim at establishing a

system of « Light Railways » (secondary lines) as economically as possible, and utilise the cheapest form of gauge.

7. — Local lines should be either of narrow gauge or of that of an existing line, as the case may be.

8. — It is advisable to draw up a general scheme.

We certainly agree with all these conclusions.

One more remark may be added. In studying the question of gauges in countries where there are three of these, it has been pointed out that the elimination of the intermediate gauge (as we have recommended for the Argentine, and as Mr. Dawson proposes for the case in India) would lead to an abnormal development of the narrow gauge, and one would then have to face the same problem in an aggravated form, since the difference of the two remaining gauges would be still greater.

Where there are three gauges in a country, the intermediate gauge is generally hybrid, neither fish nor flesh, and the lines which have been laid to it could have been, as the case may be, constructed to one of the two other gauges. In the Argentine, the 1 m. 435 gauge presents no advantages over that of the 1 m. 676 and fulfils the same purpose. In India, the intermediate gauge of 1 m. is sometimes a light railway and fulfils, to a certain extent, the same purpose as that of the 2′ 6″; while in other cases it tends to become a main line. If this is so in a country where the system is only slightly developed, a mistake has been made in not laying the broad gauge.

The case thus stated against the extension of the narrow gauge is, on the contrary, its justification, since it proves *ipso facto* its utility, subject to the condition that it should not be used in preference to the other, except after careful consideration.

COMPARISON OF GAUGES.

CHAPTER V. — *A*) INFLUENCE OF GAUGE ON CONSTRUCTION AND WORKS.

In order to make a complete survey of the question, we will examine the influence of gauge on the various expenses of construction and working.

1. **Location and preliminary surveys.** — These costs are independent of the gauge.

2. **Purchase of land.** — In the colonies and overseas countries, land is as a rule cheap, hence the difference in the cost of the land necessary for various gauges has very slight influence on the total cost of construction. In other cases this may not be so.

3. **Gradients.** — It is obvious that the limit in gradients is not directly influenced by the choice of gauge. However,

it must be recognised that it is easier in undulating ground to lay out the line with a narrow gauge than with broader gauges, and that therefore one can obtain less severe gradients in the case of the former.

4. **Radius of curves.** — The gauge has a direct influence on the curves which are permissible, and for various reasons, but one should not lose sight of the fact that lines of different gauges as a rule fulfil different requirements.

Technically speaking, there is nothing to prevent lines of all gauges being constructed with the same curves, provided the design of the rolling stock and the speed is suitable. Nevertheless, this may be a serious mistake. For the sake of clearness, we will divide this discussion into two parts :

a) The possibility of using curves of smaller radius as the gauge diminishes;

b) The advantage in favour of narrow gauges which thus allows difficult works to be avoided.

a) Possibility of using smaller radii for narrow gauges.

Let us consider the difference in the length of the two rails on a curve where :

R, is the radius of the curve;

L, the gauge, and

α, the angle at the centre of the curve.

For the outer rail, the radius will be :

$$R + \frac{L}{2}$$

and the length :

$$2\pi \frac{\alpha}{360}\left(R + \frac{L}{2}\right) = \frac{\pi\alpha}{180}\left(R + \frac{L}{2}\right).$$

For the inside rail, the radius will be :

$$\left(R = \frac{L}{2}\right)$$

and the length :

$$2\pi \frac{\alpha}{360}\left(R - \frac{L}{2}\right) = \frac{\pi\alpha}{180}\left(R - \frac{L}{2}\right).$$

The difference between the lengths of the two rails will be :

$$\frac{\pi\alpha}{180}\left[\left(R + \frac{L}{2}\right) - \left(R - \frac{L}{2}\right)\right] = \frac{\pi\alpha L}{180}.$$

This is independent of the radius.

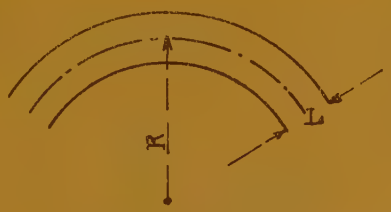


Fig. 1. — Radius of curve.

Let us consider, for example, a curve of 100 m. (5 chains) radius passing through 45°. Let us calculate the difference in the length of the two rails for the usual gauges. (See table 3.)

The difference of length between the two rails diminishes rapidly with the gauge.

On the other hand, a smaller wheel base will be used with a narrower gauge and with the sharper curves, and the train resistance will diminish with the gauge.

Mr. Morrison has tabulated this (see table 4) in lb. per English ton applied to vehicles of 12′ (3 m. 66) wheel base running round a curve of 15 chains (300 m.) radius.

TABLE 3.

GAUGE.	R = 100 m.	$\alpha = 45°$.	DIFFERENCE.
	Outer rail.	Inner rail.	
1 m. 67	79.196	77.884	1.312
1 m. 60	79.168	77.912	1.256
1 m. 435	79.104	77.977	1.127
1 m. 067	78.959	78.121	0.838
1 m. 00	78.933	78.147	0.786
0 m. 90	78.893	78.187	0.706
0 m. 75	78.835	78.245	0.590
0 m. 60	78.776	78.304	0.472
0	78.54		0

TABLE 4.

Gauge	2′	2′ 6″	3′	1 m.	3′ 6″	Standard.	5′ 3″	5′ 6″
Resistance	4.3	4.4	4.6	4.67	4.7	5.0	5.26	5.4

In exceptional cases, curves of very small radius may be employed with broad gauges, but this is only in cases of dire necessity, and it should not be concluded from this that it is permissible to use curves with as small a radius as with a track of 1 m. gauge for example (1).

The latter allows the use of curves of 100 m. (5 chains) radius, which are, however, avoided where it is possible to do so. Curves of 120 m. (6 chains) radius are permissible for a line carrying heavy traffic, and those of 150 m. (7 1/2 chains) may be freely employed on main lines.

Mr. Forster considers that for the Argentine broad gauge (1 m. 67), shunting locomotives should not be expected to pass round curves of less than 200′ (60 m.). The turnouts for goods trains should not have radii less than 600′ (183 m.), and he considers that a curve with a radius of less than 1 600′ (490 m.) is bad practice on the main line. On the other hand, he considers that with the metre gauge, curves for shunting

(1) The *Atchison Topeka & Santa Fe Railway* (U. S. A), which is of the 1 m. 435 gauge has curves of 125 m. (6 1/4 chains) radius over which are worked locomotives of the Mallet type and which haul Pullman cars which are as long as 23 m. (75 ft. 6 in.).

The *Wolgan Valley Railway* in Australia, which was constructed to the same gauge a short time ago, has curves of 100 m. (5 chains) radius and non-compensated gradients of 4 %, which is equivalent to 4.4 % on the straight.

The *Southern Pacific Railway* has a section from Bakersville to Mojave, which has 109 km. (68 inch.), on its main line, with gradients of 2.20 % and curves of 169 m. (8.45 chains) radius whereby the line rises to the summit of 1 227 m. (4 025 feet) altitude. It uses *Mogul* locomotives weighing 166 000 lb. (of which 140 000 are available for adhesion) *Consolidation* type engines of 208 000 lb. (187 000 adhesive weight), and *Mallet* 2-8-8-2 type weighing 435 000 lb. (of which 401 000 are available for adhesion).

engines may be as small as 120′ (36 m.) with radii of 250′ (76 m.) for turnouts and of 1 000′ (300 m.) on the main line.

The author of the report made to the *American Society of Civil Engineers*, which we have already mentioned, gives the following examples. He points out that the *Woodward Iron Company* uses engines of the *Mikado* type weighing 285 000 lb. (of which 200 000 lb. are available for adhesion) on gradients of 3 %, and on curves of 110 m. (5 1/2 chains) radius, that the *New York Elevated* allows curves of 30 to 40 m. (1 1/2 to 2 chains) radius, and the *New York Subway* curves of 45 m. (2 1/4 chains) radius. He concludes that with the standard gauges, lines may be laid to the same curves as narrow gauge lines, and goes even further than this. He points out that the *Kandy Railway* in Ceylon, with a 5′ 6″ (1 m. 676) gauge is worked at a moderate speed by *ten-wheeled* locomotives, in spite of curves and reverse curves of 5 chains (100 m.) radius, and he concludes that even the broad gauge may be laid to the same curves as the narrow gauge.

We attach importance to his remarks, because they have been made before a technical association of high standing, and because in the discussion which followed, the majority of persons who took part therein agreed with the author, although this is contrary to the ideas prevailing in this country.

We did not dispute that standard gauge railways and even broad gauge railways have been constructed with curves as sharp as those which may be found on the metre track, but we disagree that this is right and sound practice for lines of the same category. A metre gauge railway with curves of 100 m. radius is a workable railway under conditions which are not ideal, but which are quite admissible, but this is not the case on a standard gauge or broad gauge line which is not suitable for curves of the same radius. The wear of the tyres and of all parts of the rolling stock, as well as rail wear, is very much greater in this case, and the resistance of traction is considerably more.

b) Avoidance of difficult works.

However, the possibility of employing curves of a less radius is not the only economy of the narrow gauge. These curves often allow an obstacle to be avoided instead of having to cut through it and result in a considerable economy in construction on account of the flexibility of the line. This, among other things, is a great advantage of the narrow gauge. It is difficult to give figures, because this depends on the type of country, and although a line may have been surveyed for two gauges, it is only constructed to one of these gauges. Moreover, in comparative cases, as a rule more severe gradients are used on the narrow gauge line, and this prevents a fair comparison.

c) Radii of curves for different gauges.

On the main line, the minimum radii of curves which are allowed are as a rule the following :

Table 5.

Gauge.	Main lines.	Branch lines.
1 m. 435.	300 m.	100 m.
1 m. 000.	100 m.	60 m.
0 m. 750.	80 m	40 m.
0 m. 600.	60 m.	30 to 20 m.

In British India, the minimum radii allowed are as follows :

TABLE 6.

—	5' 6" gauge (1 m. 676).		1 m. gauge.		2' 6" gauge (0 m. 76).	
In ordinary country :						
Absolute minimum	1 146'	350 m.	716'	218 m.	238'	72 m.
Recommended minimum. . . .	1 910'	582 m.	1 146'	350 m.	...	...
In difficult country :						
Absolute minimum	573'	175 m.	358'	110 m.	...	...

5. **Loading gauge.** — As the gauge diminishes a smaller loading gauge is adopted. The economy which may result is obviously an advantage for the narrow gauge, but it is not as a rule an important matter, since on these lines the number of overhead bridges is very small.

However, this is not the case where tunnels are concerned. There are, however, other reasons why these should not be made too small, for example, the question of ventilation and sometimes the provision for a change of gauge at a later date.

Table 7 gives the principal dimensions adopted by the Argentine Government for the three gauges : broad gauge 1 m. 676; intermediate gauge 1 m. 435, and narrow

TABLE 7.

Gauge.	Height in the centre.		Breadth.		Gross section, in square metres.	
	Loading gauge.	Rolling gauge.	Loading gauge.	Rolling gauge.	Loading gauge.	Rolling gauge.
1 m. 676	4.820	4.470	4.200	3.400	17.87	14.02
1 m. 435	4.700	4.400	4.000	3.300	16.80	13.25
1 m. 000	4.120	4.070	3.500	3.200	12.99	11.48

gauge 1 m. We have also included the area of a cross section in square metres (fig. 2).

Figure 3 gives the loading gauge for the various rail gauges of the Bengal Nagpur Railway.

6. **Earthworks.** — There are no universally used proportions for earthworks, and one must be content in order to fix ones ideas with making comparisons between certain particular railways.

The cross section of an earthwork is

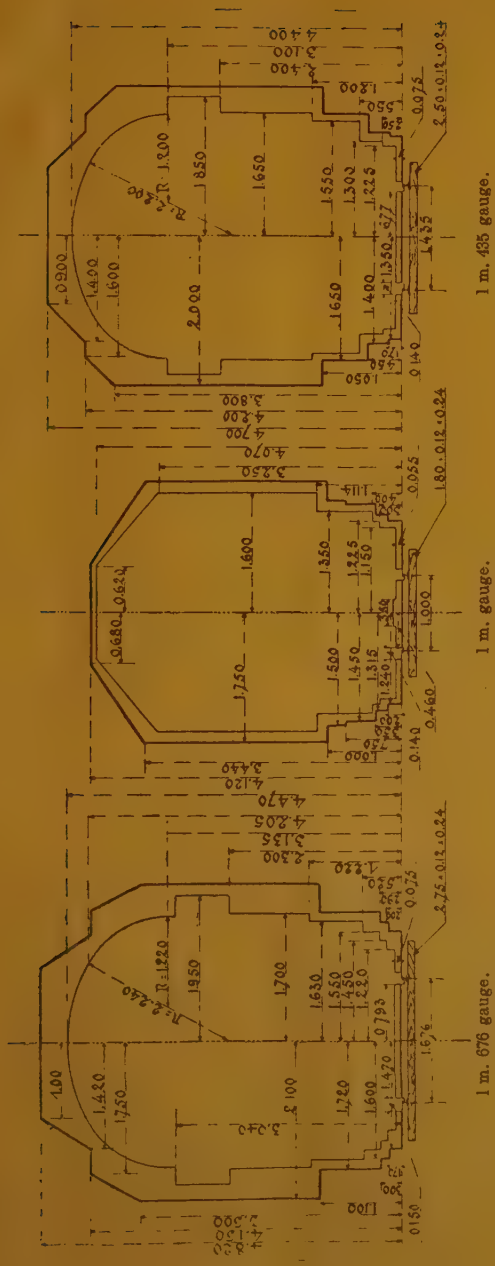


Fig. 2. — Typical loading gauges for 1 m. 676, 1 m. and 1 m. 435 gauges (Argentine Government).

identical for the various gauges, with this difference, that the slope is removed parallel to itself by a distance equal to the difference between the width of the formations, this being larger than the difference of gauges, as the width of the ditches, etc., is different in the two cases. The difference in the section is thus the area of a parallelogram whose perpendicular height is equal to the distance between the formation level and the top of the cutting or the bottom of the embankment. This parallelogram becomes less important relatively to the whole of the cross section as the height of the earthwork, whether the cutting or filling, increases.

To focus our ideas, let us take concrete examples and consider cross sections of earthwork in a standard gauge line (Belgian State) and in an important metre gauge line (the new line of the Madrid Aragon Railway). Results are given in table 8. Figures 5 and 6 give the cross sections under consideration, and figure 4 gives a graphical representation of the results. This is a rectangular hyperbola with the co-ordinates as axes.

The volume of earthwork increases proportionally to the square of the height or of the depth for the part below the sloping sides, and is proportional to the height or the depth for the part depending on the width of the formation.

The economy derived by reducing the gauge and consequently the width of the formation therefore decreases as the height or depth of the earthwork increases.

In considering this point, it is necessary to take into account the question of loading gauge. With the narrower gauges, one uses rolling stock in which the lateral overhang may be proportionally greater on account of the lower centre of gravity and moderate speeds, and this

leads to an increase in the loading gauge which may necessitate a wider formation.

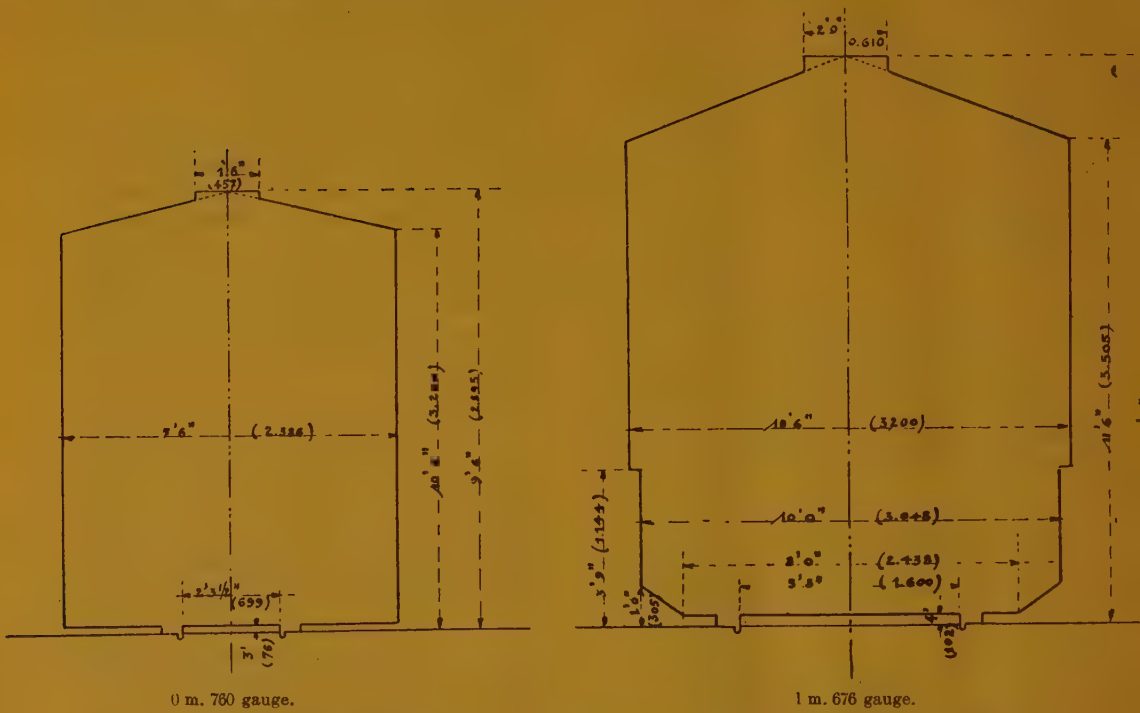


Fig. 3. — Bengal Nagpur Railway. — Loading gauges for 0 m. 760 and 1 m. 676 gauges.

It may be mentioned that a direct comparison of earthworks of the same depth for lines of different gauges does not give a complete statement of the economy which may be gained, because it does not take into account the gradients and curves which are allowable. In practice, the steeper the gradient which may be permitted, the more quickly will obstacles be surmounted, and the amount of earthwork will thereby be reduced. The same is true as regards the curves, because the smaller the minimum radius which is allowed, the more flexible will the line be and it will thereby avoid obstacles and reduce still further the amount of earthwork.

If the line under consideration runs through a country where these advantages allow an appreciable economy, they may be decisive factors in favour of the adoption of a narrow gauge. This will not be the case where the country traversed does not allow sufficient advantage to be obtained on this account.

Moreover, the advantage resulting from the fact that the proportion of paying load to the total load becomes more favourable as the gauge diminishes, counterbalances the inconvenience due to the decreased power of the locomotives employed.

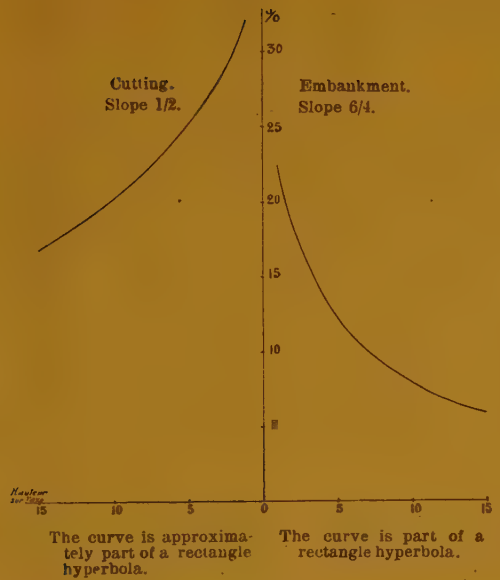
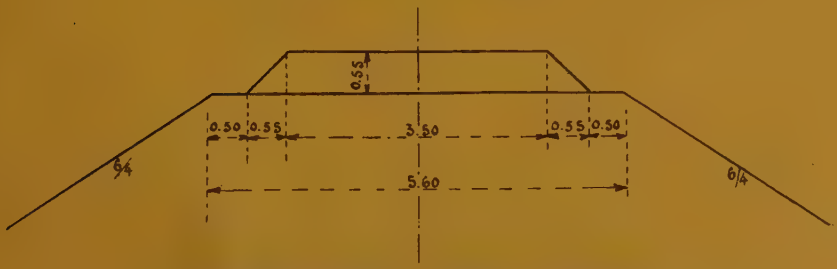
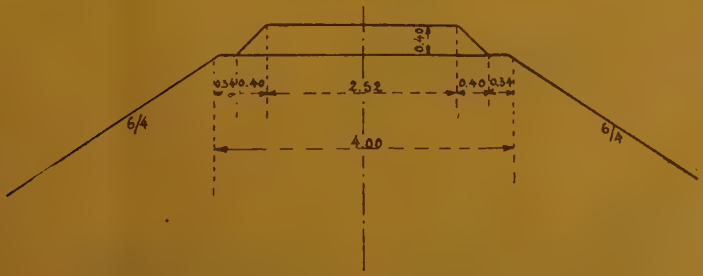


Fig. 4. — Comparison of earthwork for a broad gauge and narrow gauge line.

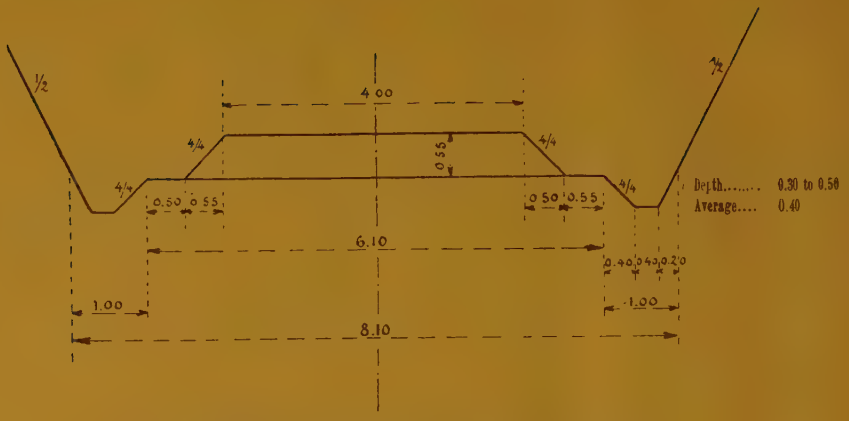


Belgian State Railways. — Diagram of cross section.

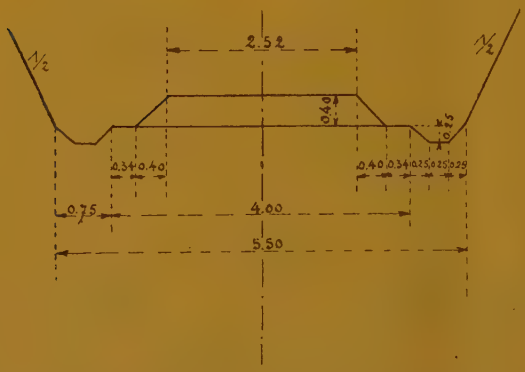


Madrid-Aragon Railway. — Diagram of cross section.

Fig. 5. — Cross section of embankments.



Belgian State Railways. — Diagram of cross section.



Madrid-Aragon Railway. — Diagram of cross section.

Fig. 6. — Cross section of cuttings.

7. Bridges, tunnels, etc. — From the foregoing point of view (comparison of similar works on different gauges) we may divide engineering works into four categories :

a) Works in which the dimensions depend only on the gauge.

This is the case with tunnels : as we have said, loading gauges are only partially the deciding factor, since the section of the tunnel should be sufficient to ensure satisfactory ventilation and safety.

b) Works of which the dimensions are dependent on the difference between the rail level and that of the natural level of the land.

This is the case with aqueducts and overbridges in which the economy which can be realised depends on the distance between the slopes and is of the same

TABLE 8.

Cutting. — Slope : 1/2.					Filling. — Slope : 6/4.				
Height at centre line.	Broad gauge.	Narrow gauge.	Difference.	Per cent.	Height at centre line.	Broad gauge.	Narrow gauge.	Difference.	Per cent.
0	0.56	0.25	0.31	...	0	...	...	...	...
1	9.16	6.35	2.91	31.80	1	7.10	5.50	1.60	22.60
2	18.76	13.25	5.51	29.35	2	17.20	14.00	3.20	18.60
3	29.36	21.25	8.71	27.65	3	30.30	25.50	4.80	15.85
4	40.96	30.25	10.71	26.15	4	46.40	40.50	6.40	13.80
5	53.56	40.25	13.31	24.88	5	65.50	57.50	8.00	12.20
6	67.16	51.25	15.91	23.70	6	87.60	78.00	9.60	10.95
7	81.76	63.25	18.51	22.70	7	112.70	101.50	11.20	9.95
8	97.36	76.25	21.11	21.75	8	140.80	128.00	12.80	9.10
9	113.96	90.25	23.71	20.80	9	171.90	157.50	14.40	8.37
10	131.56	105.25	26.31	19.95	10	206.00	190.00	16.00	7.77
11	150.16	121.25	28.91	19.20	11	243.10	225.50	17.60	7.23
12	169.76	138.25	31.51	18.55	12	283.20	264.00	19.20	6.77
13	190.36	156.25	34.11	17.90	13	326.30	305.50	20.80	6.37
14	211.96	175.25	36.71	17.30	14	372.40	350.00	22.40	6.01
15	234.56	195.25	39.31	16.75	15	421.50	397.50	24.00	5.70
h	...	...	$2.60\,h + 0.31\,h$	...	h	$(5.6 + 1.5\,h)\,h$	...	$1.60\,h$	$\frac{1.60}{5.6 + 1.5\,h}$

order as for the earthworks, which we have mentioned above. It will, moreover, be less where the difference between the rail level and the natural level of the land is greater.

c) WORKS IN WHICH THE DIMENSIONS DEPEND ON THE DIFFERENCE OF GAUGE AND ALSO ON THE DIFFERENCE OF RAIL LEVEL AND THE NATURAL LEVEL OF THE LAND.

This is the case of bridges and viaducts in which a large proportion of the expense is independent of the gauge and of the loads carried.

For this reason, in India, bridges on certain lines of 2′ 6″ gauge are constructed for a metre gauge; on the other hand, in the Punjab, the 5′ 6″ gauge is laid on bridges constructed for the metre gauge, it being merely laid down that trains should decrease their speed when crossing.

The conclusion to be drawn is, that for small axle loads and low speed, there is little economy on this account in favour of the narrow gauge, and this economy decreases as the length of the spans increases.

The side walls are independent of the gauge.

The economy in the size of piers and abutments is not very great, especially if the foundations are large (1).

d) WORKS IN WHICH THE DIMENSIONS ARE INDEPENDENT OF THE GAUGE AND ALSO OF THE RAIL LEVEL AS COMPARED WITH THE NATURAL LEVEL OF THE LAND.

Works of this class are of less importance from the point of view with which we are dealing.

8. — **Formation.** — The width of the formation is obviously less as the gauge itself is less.

The drainage ditches may be of smaller section for narrow gauges, since they have to deal with the water, given off a smaller surface. In British India the difference between the width of the formation for a line of 1 m. 676 gauge and of a line of 1 m. gauge is only 4′ 6″ (1 m. 37) in cuttings, and 2′ 6″ (0 m. 76) on embank-

(1) The following are a few figures on this point taken from E. H. Stone's work for the « East Indian Railway », entitled : *Bridge and Culvert Tables.*

Span	Height of embankment	Two abutments and one pier.				One span.	
		Concrete.		Masonry.			
		Cubic feet : 5′ 6″.	Cubic feet : metre.	Cubic feet : 5′ 6″.	Cubic feet : metre.	Tons : 5′ 6″.	Tons : metre.
6′	10′	1.579	1.395	4.529	3.850	0.74	0.48
12′	10′	1.838	1.634	5.159	4.402	1.44	1.15
12′	20′	3.605	3.321	15.644	13.982	1.44	1.15
20′	10′	2.1?6	1.911	6.055	5.137	3.14	2.37
20′	20′	4.054	3.728	17.457	15.528	3.14	2.37
20′	30′	6.559	6.151	38.251	35.007	3.14	2.37
40′	20′	4.461	4.121	21.616	19.318	9.65	7.66
40′	30′	10.259	9.759	81.430	75.982	9.65	7.66

ments, the minimum width being as follows :

0 m. 76 gauge . . . . 12′ (3 m. 66);
1 m. 00 gauge . . . . 14′ (4 m. 27);
1 m. 676 gauge. . . . 16′ 6″ (5 m. 03).

Figure 7 gives similar information for the Chilian State Railways.

In Germany, the width of the roadbed measured at the level of the bottom of the rails is :

4 m. (13′ 1 1/2″) for main lines of 1 m. 435 gauge (4′ 8 1/2″);
3 m. 50 (11′ 5 3/4″) for secondary lines of 1 m. 435 gauge;
3 m. (9′ 10″) for local lines of 1 m. 435 gauge;
2 m. (6′ 6 3/4″) for lines of 1 m. gauge (3′ 3 3/8″);
1 m. 50 (4′ 11″) for lines of 0 m. 75 gauge (2′ 5 1/2″);
1 m. 20 (3′ 11 3/4″) for lines of 0 m. 60 gauge (1′ 11 5/8″).

9. **Track.** — A reduction in gauge does not always imply the use of an economical rail, as the axle load is independent of the gauge (1). This is not so, however, in the case of the sleepers, which are shorter and of smaller cross section for narrow gauges.

On the other hand, it is good practice to increase the rigidity of the narrower gauges, especially on curves, by using a larger number of sleepers, which tends to counteract the above economy.

The Argentine Government has fixed the dimensions of sleepers for various gauges, and these we give in table 9.

TABLE 9.

Dimensions for sleepers for various gauges.

Gauge.	Dimensions of typical sleepers.				Volume per cent of the broad gauge sleeper.
	Length.	Breadth.	Depth.	Volume : cubic metres.	
Dimensions of sleepers as fixed by the *Argentine State* :					
1 m. 676	2 m. 75	0 m. 24	0 m. 12	0 m. 0792	100
1 m. 435	2 m. 50	0 m. 24	0 m. 12	0 m. 0720	91
1 m. 000	1 m. 80	0 m. 24	0 m. 12	0 m. 0518	65
Sleepers for the *South African Railways* :					
1 m. 067	2 m. 13	0 m. 254	0 m. 127	0 m. 0687	100
	1 m. 98	0 m. 229	0 m. 114	0 m. 0517	75
0 m. 600	1 m. 67	0 m. 178	0 m. 114	0 m. 0341	50
Typical dimensions in accordance with the *German regulations* :					
1 m. 435 (main lines)	2 m. 70	0 m. 25 (*a*) to 0 m. 30 0 m. 16 to 0 m. 20 (*b*)	0 m. 16	...	...
1 m. 435 (secondary lines)	2 m. 70 to 2 m. 30	0 m. 26	0 m. 16	...	...
		0 m. 24	0 m. 15	...	...
1 m. 000	1 m. 75	0 m. 20	0 m. 14	...	...
0 m. 750 (Wurtemberg)	1 m. 50	0 m. 18	0 m. 13	...	...
0 m. 600	1 m. 20	0 m. 17	0 m. 10	...	...

(*a*) At the bottom. — (*b*) At the top

(1) The influence of the decrease in the length of axle is negligible.

The superelevation to be provided at curves is directly dependent on the gauge. It depends mainly on the speed and differs in various countries. We will confine ourselves to giving a few formulæ for fixing this (1). As an example, for a radius of 1 000′ (304 m.) and a speed of 40 miles (64 km. 4), the superelevation for gauges of 1 m. 676, 1 m. 435 and 1 m. 067 are as shown. (See table 10).

TABLE 10.

Gauge.	RAILWAY.	Superelevation	
		in inches.	in millimetres.
1 m. 676.	Central Argentine Railway	...	179
	North Western of India	8″ 91	226
1 m. 435.	United States and England	from 6″ 03 to 6″ 40	from 153 to 162
1 m. 067.	New Zealand Government Railways.	4″ 52	115
	South African Railways	4″ 48	113

10. **Ballast.** — This heading is the one on which a difference in the gauge has the greatest effect. It is difficult, however, to give figures, because the quality of ballast and the class of road under consideration have a considerable influence on this question. We will content ourselves in this matter by giving the case of British India where these figures are fixed by regulations :

TABLE 11.

1 m. 676 gauge.	1 m. gauge.	BRITISH INDIA.	1 m. 676 gauge.	1 m. gauge.
10′	7′	Minimum breadth at the level of the bottom of the rail	3 m. 05	2 m. 13
11′	7′ 6″	Recommended breadth	3 m. 35	2 m. 28

(1) In Germany, the practice is as follows (circular B 0566 of the 1 May 1905) :

On main line railways of standard gauge :

$$h\ (\text{in m.}) = \frac{\text{V km. per hour}}{2\,\text{R in metres}} \quad \text{or} \quad h\ (\text{in mm.}) = \frac{3\,\text{V in metres}}{5\,\text{R in metres}}.$$

On secondary lines of standard gauge :

$$h = \frac{11.8\,V^2}{R};$$

$$h = \frac{s V^2}{127\,R} \text{ in Bavaria (where V is 30 km. per hour);}$$

$$h = \frac{500\,V}{R} \text{ in Wurtemberg with } h \text{ maximum} = 125.$$

On narrow gauge lines :

1 m. gauge . . . . $h = \frac{8.3\,V^2}{R}$;

0 m. 75 gauge . . . $h = \frac{6.2\,V^2}{R}$;

0 m. 60 gauge . . . $h = \frac{5\,V^2}{R}$;

and in Wurtemberg :

1 m. gauge . . . . $h = \frac{200\,V}{R}$, h max. = 80 mm.

0 m. 75 gauge . . . $h = \frac{160\,V}{R}$, h max. = 60 mm.

We also give as an example (fig. 7) the cross section of the Chilian Railways.

If one provided the same depth of ballast beneath the sleepers, there would be a still further economy in favour of the narrow gauge, since the depth of the sleepers is less and the depth, as well as the breadth of the bed of ballast would be smaller.

Mr. Claisse recommends (1) that for local lines the thickness should not be less than 35 cm. (1′ 1 3/4″) for a gauge of 1 m. (3′ 3 3/8″) or 45 cm. (1′ 5 3/4″) for standard gauge. Based on this he gives the width of the road bed, including the slopes, of 4 m. to 4 m. 20 and 5 m. 10 (13′ 1 1/2″ to 13′ 9 3/8″ and 16′ 9″) respectively.

11. **Buildings.** — The only buildings influenced by the gauge are goods sheds, engine sheds and repair shops for locomotives and rolling stock.

12. **Comparison of various particulars for lines of different gauges belonging to the same railway.** — Some railways have various gauges in their system. The following are some particulars (table 12) which compare certain details in use in British India, Africa and Australia :

TABLE 12.

RAILWAY.	1 m. 676.	1 m.	0 m. 760.
Formation (width on embankments and cuttings) (a).			
South Australia	5 m. 49 — 5 m. 03	4 m. 27 — 3 m. 81	...
Madras & Southern Mahratta Railway.	6 m. 10 — 5 m. 49	4 m. 88 — 6 m. 71	...
Eastern Bengal Railway	6 m. 10 — 5 m. 49	4 m. 88 — 6 m. 71	...
Bombay, Baroda & Central India Railway.	6 m. 10 — 5 m. 49	4 m. 88 — 4 m. 27	...
South Indian Railway	6 m. 10 — 5 m. 49	4 m. 88 — 4 m. 27	0 m. 305 — 0 m. 274
Rails (c).			
South African Railways	...	39 kgr. 7	17 kgr. 2 (*b*)
Madras & Southern Mahratta Railway.	44 kgr. 6	30 kgr. 75	...
Bombay, Baroda & Central India Railway.	44 kgr. 6	29 kgr. 7	...
Eastern Bengal Railway	44 kgr. 6	24 kgr. 8	...
South Indian Railway	39 kgr. 7	24 kgr. 8	14 kgr. 9
Sleepers.			
South African Railways	2.54×0.254×0.127	1.98×0.203×0.114	...
Madras & Southern Mahratta Railway.	2.74×0.254×0.127	1.83×0.203×0.114	...
Bombay, Baroda & Central India Railway.	2.74×0.254×0.127	1.83×0.203×0.114	...
Eastern Bengal Railway	2.74×0.254×0.127	1.83×0.203×0.114	...
South Indian Railway	2.74×0.254×0.127	1.83×0.203×0.114	1.62×0.178×0.102
Maximum axle load.			
Madras & Southern Mahratta Railway.	17 t. 3	10 t. 2	...
South Indian Railway	16 t. 3	9 t. 1	6 t. 1
Eastern Bengal Railway	18 t. 3	10 t. 2	6 t. 1
Superelevation for a radius of 304 m. and a speed of 64 km. per hour.			
(Standard gauge 6 to 6.4)	8″ 9	4″ 5	...

(*a*) 3′ 6″ gauge (1 m. 067). — (*b*) 2′ gauge (0 m. 610). — (*c*) We give in figure 8 the sections of rails used by the *Chilian State* for the various gauges.

(1) *Annales des ponts et chaussées*, January 1919.

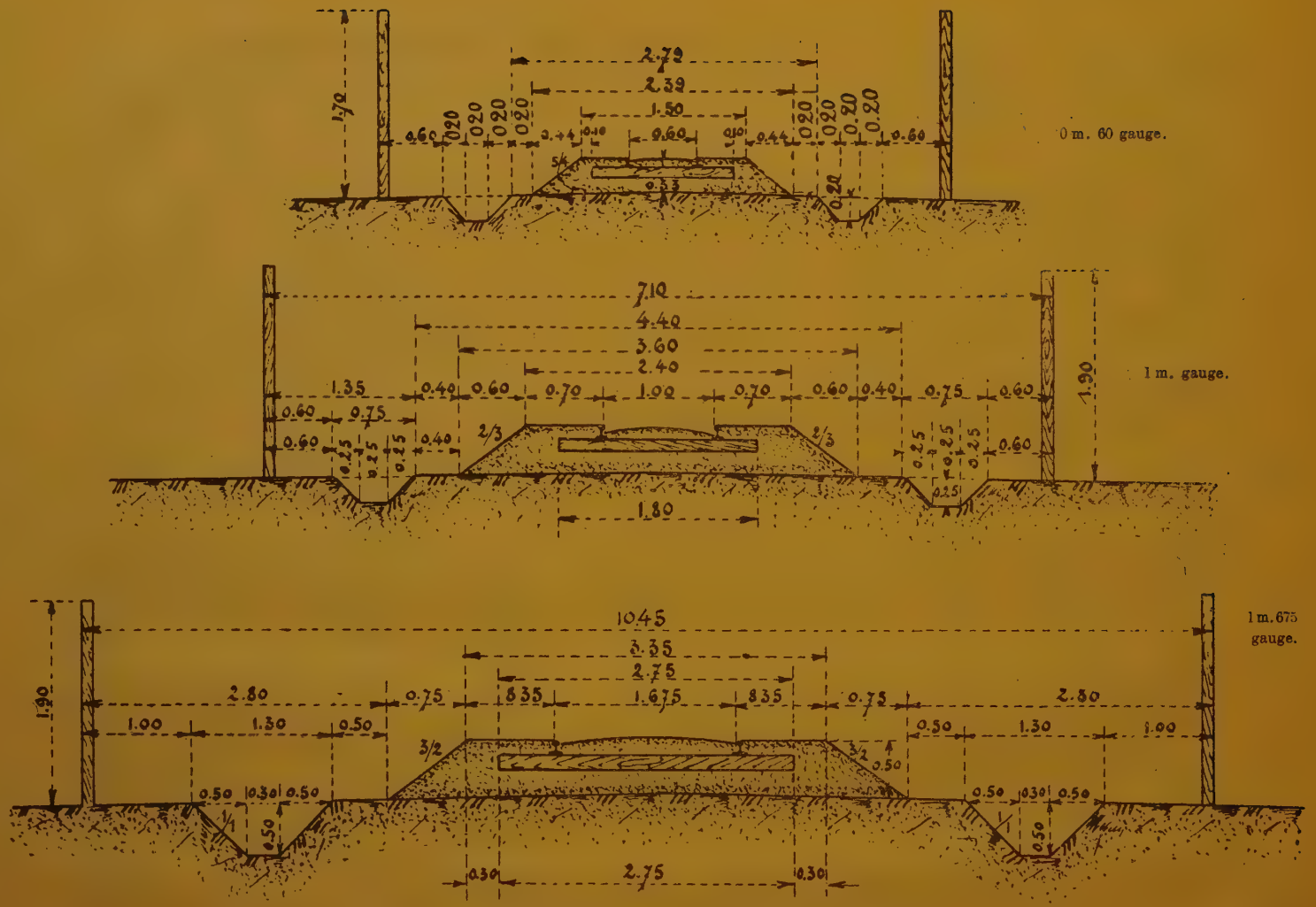
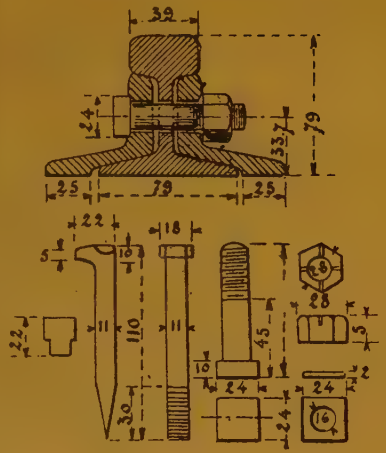
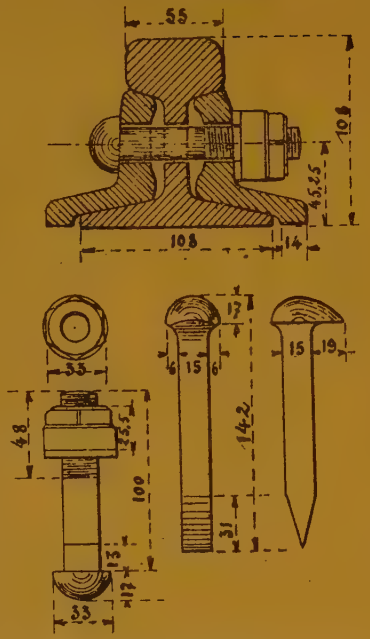


Fig. 7. — Chilian State Railways. — Cross section in flat country.

Rails for 0 m. 60 gauges.



Rails for 1 m. gauges.



Rails for 1 m. 675 gauges.

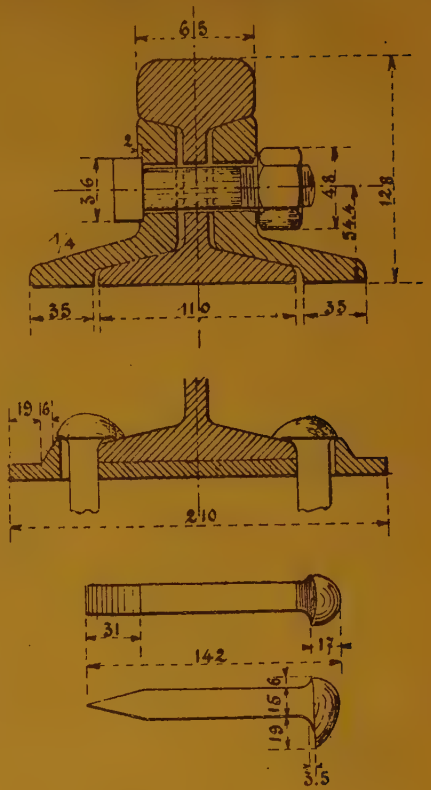


Fig. 8. — Chilian State Railways.

13. Comparison between various costs of construction. — The following figures are only given as a guide. Throughout we have given pre-war prices, as present day conditions are still too unstable. Even so, it is necessary to be cautions in dealing with this matter, as conditions vary, not only in one country as compared with another, but also between different lines and for different sections of the same line. With these reservations the following figures are of interest.

I) South Africa (1 m. 067 and 0 m. 61). — We give some particulars regarding the cost of construction of 3′ 6″ (1 m. 067) gauge lines of the *Union of South African Railways* and also for 2′ (0 m. 61) gauge lines. They show the danger of making comparisons without at the same time carefully considering all the elements of each case.

We give for the two gauges in accordance with the *Official Year Book of South Africa* for 1920 (No. 4) the cost of constructing a unit length of line as at the 31 March 1920, including lines which were costly and lines which were cheaper to build, and also the average cost of all these lines. (See table 13.)

The only conclusion that can be drawn from this is, that the 2′ gauge lines have been much cheaper to build than the 3′ 6″ gauge lines.

Table 13.

Cost of construction of certain lines of the South African Railways.

SECTION OF LINE.	Length		Cost per mile	
	in miles.	in kilometres.	in pounds sterling per mile.	in francs per kilometre (25 fr. 20 = £1)
1 m. 067 gauge.				
Salt River Wynberg	6	10	18 501	279 735
Braamfontein Germistown	10	16	17 377	273 687
Point to Transvaal border	309	497	12 299	192 695
Buffalo harbour Queenstown	166	267	10 222	160 152
Vereeniging Ressano Garcia	382	615	9 990	156 369
Port Elisabeth Cradock	181	292	9 682	151 238
Mafeking West Rand Junction	168	270	2 511	39 372
Barklay Bridge Alexandria	54	87	2 460	38 477
Fauresmith Koffyfontein	33	55	2 184	34 268
General average at 31 December 1919	...	...	8 035	125 843
0 m. 61 gauge.				
Alfred County line	76	122	3 120	48 978
Esperanza Donnybrook	96	155	3 209	50 085
Port Elisabeth Avontuur	176	283	3 052	51 468
Pienaars River to Settlers	27	43	620	9 808
General average at 31 December 1919	...	...	2 798	43 822

II) National light railways of Belgium (secondary lines of 1 m. 435 and 1 m. gauge). — Cost per kilometre on the 31 December 1913 of lines worked by steam power.

Table 14.

—		1 m. and 1 m. 067 gauge.	1 m. 435 gauge.
General expenses and sundry charges	Francs.	6 978	10 128
Purchase of land	—	8 149	15 297
Constructional work and purchase of material.	—	26 029	40 405
Buildings and structures	—	9 381	20 944
Rolling stock	—	10 976	16 242
Total cost per kilometre.	Francs.	58 739	106 664

III) Styria (lines of 1 m. 435 and 1 m. gauge). — Table given by Mr. Wurb, Director of the Styrian Railways, 1902.

Table 15.

Nature of country.	1 m. 45 gauge.	1 m. gauge.
	In thousands of francs.	In thousands of francs.
Level	37 to 62	25 to 40
Slightly undulating	57 to 87	37 to 62
Very undulating	75 to 112	57 to 75
Slightly hilly	100 to 150	62 to 87
Very hilly	137 to 175	75 to 112
Slightly mountainous	162 to 200	100 to 137
Very mountainous	187 to 250	125 to 175

IV) Germany. — Cost of constructing lines of 0 m. 60 and 1 m.

Table 16.

1906	Length		Cost of construction including rolling stock (1)	
	in kilometres.	in miles.	per kilometre in marks.	per mile in pounds sterling.
0 m. 60 gauge.				
Anklam-Lassau	30.4	18.9	22 400	1 767
Bachwitz-Lindenwald	5.0	3.1	18 400	1 451
Bromberger Kreisbahnen	90.4	56.2	20 140	1 588
Hoyerswerda-Schecktal	10.0	6.2	10 100	796
Mecklenburg-Pomeranian	150.9	93.8	17 230	1 360
Wallücker Kleinbahnen	17.2	10.7	28 460	2 245
Wirsitzer Kreisbahnen	74.4	46.2	23 400	1 846
Zniner Kreisbahnen	40.0	24.8	17 900	1 412
Witkowoer Kleinbahnen	56.0	34.8	14 300	1 128
	474.3	294.7		
Average cost of construction based on a total of 9 041 895 Marks = £442 579	...	...	19 063	1 502

(1) Conversions at the pre-war rate of exchange.

TABLE 16 (*continued*).

1906	Length		Cost of construction including rolling stock (1)	
	in kilometres.	in miles.	per kilometre in marks.	per mile in pounds sterling.
1 m. gauge.				
Feldabahn	44.00	27.3	32 200	2 539
Hildburghausen-Heldburg	30.00	18.6	26 670	2 108
Pfälzische Eisenbahnen	36.79	22.9	47 490	3 745
Kreis Altenaer Schmalspurbahnen	34.59	21.5	67 020	5 285
Eckernföred-Kappeln	28.70	17.9	30 100	2 374
Flensburg-Kappeln	51.68	32.1	24 380	1 923
Kaisersberger Talbahn	24.66	15.3	63 690	5 023
Darmstädter Strassenbahn (steam service)	17.61	10.9	39 300	3 100
Gernrode-Harzgerode	43.50	27.0	50 580	3 990
Weimar-Rastenberg	53.87	33.4	51 490	4 061
Wermelskirchen-Burg	11.20	7.0	46 860	3 695
Ronsdorf-Müngsten	15.10	9.4	66 430	5 239
Zell-Todtnau	18.76	11.7	72 230	5 688
	410.46	255.00		
Average	...	....	45.130	3 750

(1) Conversions at the pre-war rate of exchange.

The average cost in Germany is therefore as follows :

TABLE 17.

Gauge.	Marks per kilometre.	Pounds sterling per mile.
600 mm.	19 063	1 502
1 000 mm.	45 130	3 750

600 mm. (1′ 11 5/8″) gauge therefore costs only 40 % of the cost of the metre (3′ 3 3/8″) gauge. The standard gauge local railways cost according to Zezula (Sarajewo, 1893), 75 045 marks as an average for Central Europe, without rolling stock, and the German main lines of standard gauge 255 850 marks.

The following gives relative cost of construction of lines of different gauges according to investigations made by different German authorities :

TABLE 18.

	Gauge.			
	1 m. 437	1 m. 000	m. 750	0 m. 600
L. Troske	1	0.67	0.47	0.28
A. Liebmann (1)	1	0.67	0.58	0.33
Schwabe (2)	1	0.67	0.47	0.28

(1) *Zeitschrift für Kleinbahnen*, I, 1906.
(2) *Glasers Annalen*, 1905, p. 101.

V) INDIA. — COST OF CONSTRUCTION (according to the *Victoria Report*, p. XXXII.

TABLE 19.

Gauge.	Pounds sterling per mile.	Ratio.
0 m. 610	4 500	1.00
1 m. 000	7 210	1.60
1 m. 676	16 274	3.62

VI) Cost of construction of lines of 1 m. and 0 m. 60 (according to Koppel) (1) :

Table 20.

Railway.	Cost of construction (a), including rolling stock.		Railway.	Cost of construction (a), including rolling stock.	
	Per kilometre, in marks.	Per mile, in pounds sterling.		Per kilometre, in marks	Per mile, in pounds sterling.
0 m. 60 and 0 m. 61 gauges.			Wirsitzer Kreisbahnen .	23 400	1 846
Darjeeling-Himalaya . .	53 306	4 204	Witkowoer Kleinbahnen .	14 300	1 128
Festiniog-Bahn	136 018	10 727	Zniner Kleinbahnen . .	17 900	1 412
Pithiviers-Toury. . . .	19 667	1 551	Otavi-Bahn	30 700	2 416
Caen-Dives	27 173	2 143	*1 m. and 1 m. 067 gauges.*		
Anklam-Lassau	22 400	1 767	In Germany	45 130	3 750
Bachwitz-Lindenwald . .	18 400	1 451	In India	74 570	5 882
Bromberger Kreisbahnen.	20 140	1 588	In Tasmania	105 980	8 358
Hoyeswerda-Scheckthal .	10 100	796	In Cap Colony (1 m. 067 gauge)	111 600	8 802
Mecklenburg-Pommersche Bahn	17 230	1 360	In Switzerland (Rhætian Railways).	214 616	16 903
Wallücker Kleinbahnen .	28 460	2 245			

(a) Conversions at the pre-war rate of exchange.

Conclusions. — Narrow gauge lines lead to an economy in construction as regards first cost :

There is considerable saving on account of the possibility of using curves of less radius which allow easy construction, and there is an economy resulting from the adoption of a smaller loading gauge;

From the point of view of the track, there is an economy due to the use of sleepers of smaller section, of less ballast, narrower formation and less important earthworks;

There is further economy as regards engineering structures and in some of the necessary buildings.

(1) June 1906.

CHAPTER VI. — *B*) INFLUENCE OF GAUGE ON ROLLING STOCK.

We will deal with this question in the following order : locomotives, carriages and wagons.

1. Locomotives. — It may be shown that the power of a locomotive is not dependent on the gauge, as the tractive effort which is proportional to $\frac{pd^2l}{D}$, is independent of the width of the track.

However, it will be found more difficult to accommodate large cylinders on locomotives for lines with the smaller rail and loading gauge especially as the power increases.

The speed is not altogether independent of the gauge. As the dimensions of the cylinders are limited by the loading gauge and as the piston speed is limited by conditions necessary for the construction and efficient operation of these parts, there will be a limit which cannot be exceeded, and which, moreover, will depend on the evaporative capacity of the boiler.

In practice, one can hardly exceed 80 km. (50 miles) per hour on a metre gauge track in a very good condition, and from 60 to 70 km. (37 to 43 1/2 miles) per hour on a metre gauge track in a fairly good condition.

The *Hannoversche Maschinenbau Gesellschaft* has drawn up some interesting rules giving the relationship between the principal dimensions of a locomotive which vary directly with the gauge.

If E be the wheel base in millimetres;

L the width of the track,

and c the height of the centre of the boiler,

$$c = AE + BL,$$

A and B being coefficients which vary with the gauge. By considering a series of locomotives and dividing the gauges into three groups only for greater simplicity, the following values may be adopted :

For broad gauges of 1 m. 524 to 1 m. 676 :
$0.01\,E + 1.98\,\alpha L.$

For standard gauges of about 1 m. 435 :
$0.03\,E + 1.94\,\alpha L.$

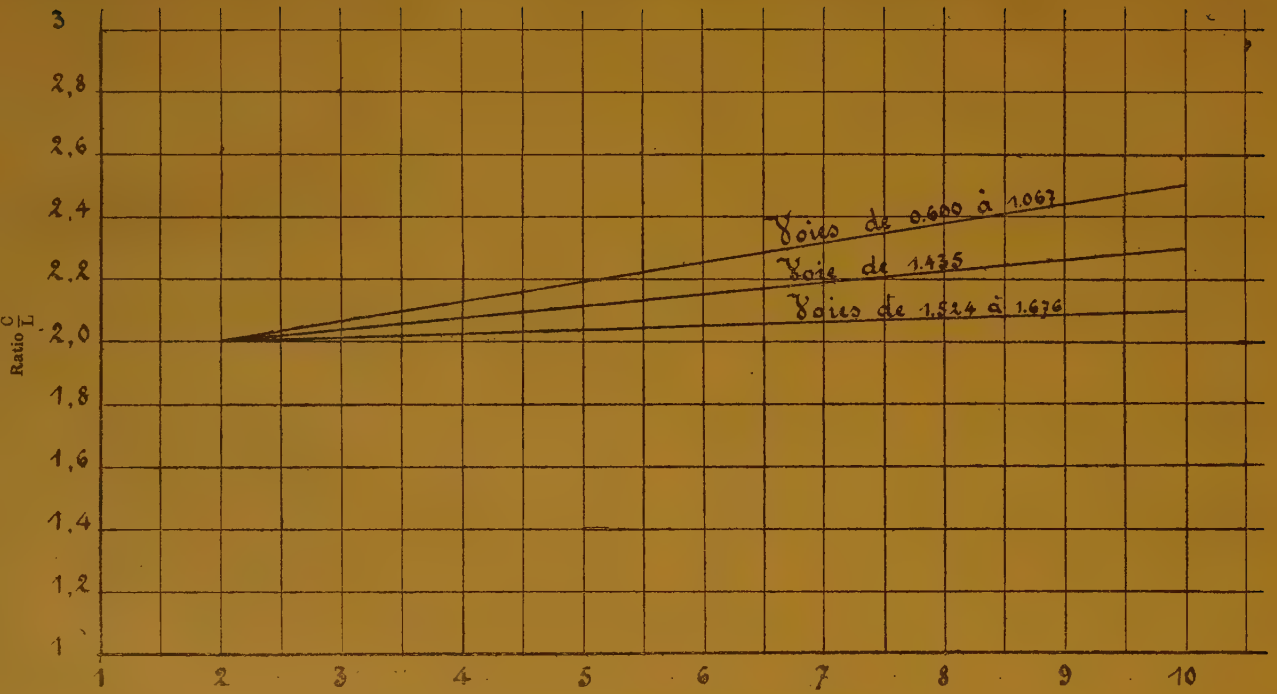
For narrow gauges of 0 m. 600 to 1 m. 067 :
$0.06\,E + 1.88\,\alpha L.$

Figure 9 gives these formulæ in a graphical form.

Influence of the gauge also makes itself felt as regards locomotive types in another way. The more curves that occur in a line, the more is the rigid wheel base reduced, and the more important it is to guide the locomotive by radial trucks or bogies.

As a rule curves of a less radius are used with narrow gauges, and one finds a still greater proportion of tender engines with leading carrying wheels or bogies. In the case of locomotives which have to run equally well in either direction, such as tank engines, one will find as a rule that there are radial trucks or bogies at both ends.

On the other hand, a broad gauge gives greater freedom in designing the firebox and ashpan, and therefore tender engines



L = Gauge. — C = Height of centre line of boiler above rail level.

Fig. 9. — Permissible height of centre line of boiler as determined by the gauge and wheel base.

as a rule have no carrying axle at the trailing end. As a matter of fact, in the case of the eleven types of which we have given particulars, only three have a radial truck at the trailing end, the eight others not being provided with this feature.

As however the gauge becomes smaller, the opposite tends to become the case. Out of the nine examples quoted for the 0 m. 75 gauge, four are without radial trucks, four with radial trucks and one with a bogie at the trailing end, while for the 0 m. 60 gauge, half of the engines quoted have a trailing radial truck.

We will now deal with the question of the coupled wheels. It may be noted that the greatest variety of types will be found in the case of lines of average gauge, while there is a reduction in the number of coupled wheels both as a maximum and as a minimum for the broader as well as for the narrower gauges, and this results from different reasons.

If one finds on a broad gauge engines ranging from four coupled to eight coupled, one will find that the majority are six coupled or eight coupled engines. Single wheel engines are never built, and four wheel coupled engines are only employed on a relatively small scale. The reason is, that this gauge is used as a rule in new countries, where the main line trains are frequent and as a rule heavy so as to diminish the number. One does not as a rule employ ten coupled engines, because the gauge admits easy accommodation of the boiler and firebox under the best possible conditions.

Standard gauge railways as a rule use locomotives with four to ten coupled wheels. Single wheel engines have disappeared as not being sufficiently powerful, while twelve coupled engines are rare, as the rigid wheel base is too great in this case.

Let us consider the case of still narrower gauges. It becomes more difficult to carry a boiler of large capacity on narrow gauge engines, and this accounts for the elimination of types having a small number of coupled wheels. On the other hand, the types which have a large number of coupled wheels are also undesirable on account of the large number of curves of a small radius. One therefore finds that in the majority of cases engines have six coupled wheels. The 0 m. 75 gauge has a certain number of examples of eight coupled engines, but these are rare on the 0 m. 60 gauge.

As a general rule, there is in the case of all engines a tendency to reduce the number of existing types, and those with the least number of coupled wheels are eliminated, while the types with an extra coupled wheels are added to.

We have endeavoured to give in table 21 the majority of engine types in use at the present time on lines of various gauges. This task, which has been extremely laborious, is not perhaps altogether complete, but it shows, however, sufficiently well the types of engines used for various gauges as regards the wheel arrangement.

2. Passenger carriages. — It has been stated that the height of vehicles is the same whatever the gauge, and that this is the cause of the inferiority and instability of narrow gauge stock.

This is not always the case in practice, for as the diameter of the wheels is less in the case of narrow gauge vehicles, the height of the floor above the rail level is also less. Moreover, so as to obtain a lower centre of gravity, the body is given a less height, which is, however, still sufficient. This is an important point, since the lateral overhang becomes greater as the gauge becomes less, which is a disadvantage.

Table 21.

Types of locomotives employed on lines of various gauges.

(L = tender engine. — T = tank engine).

Type.	1 m. 676		1 m. 600		1 m. 435		1 m. 067		1 m.		0 m. 910		0 m. 750		0 m. 600	
4-2-2. . .	...	...	...	...	...	L	...	...	...	...	..	...	...	...	...	...
0-4-0. . .	...	...	...	...	T	L	...	...	...	...	...	...	T	...	T	...
0-4-2. . .	...	...	...	...	...	...	...	...	...	...	...	...	T	...	T	...
0-4-4. . .	T	...	...	...	T	...	...	...	T	...	...	...	...	...	T	...
2-4-0. . .	...	...	...	...	...		...	...	T	...	...	...	...	...	...	...
2-4-2. . .	...	...	...	...	T	L	T	...	...	...	...	...	...	...	T	...
2-4-4. . .	...	...	T	...	...	...	...	...	T	...	...	...	...	...	...	...
4-4-0. . .	T	L	...	L	T	L	...	L	T	L	T	...	...	L	...	...
4-4-2. . .	...	L	T	...	T	L	...	L	...	L	T	...	...	...	T	...
4-4-4. . .	T	...	...	...	T	L	T	...	...	...	...	...	...	..	...	...
0-6-0. . .	...	L	...	L	T	L	T	..	T	...	..	L	T	...	T	L
0-6-2. . .	T	...	...	...	T	...	T	L	T	...	...	L	T	L	...	...
0-6-4. . .	T	...	...	...	T	...	T	...	T	...	T	...	T	...	...	..
2-6-0. . .	...	L	...	...	T	L	T	L	T	L	...	L	..	...	...	L
2-6-2. . .	T	...	...	...	T	L	T	L	T	...	...	...	...	L	T	...
2-6-4. . .	T	...	...	...	T	L	T	L	T	...	T	...	...	...	...	...
4-6-0. . .	...	L	...	L	T	L	...	L	T	L	...	L	...	L	T	...
4-6-2. . .	...	L	...	...	T	L	T	L	...	L	T	...	...	L	T	L
4-6-4. . .	T	...	T	...	T	L	T	...	T	...	T	...	T	...	...	...
0-8-0. . .	T	L	...	...	T	L	...	...	T	...	...	...	T	L	T	...
0-8-2. . .	...	...	...	...	T	...	...	...	T	...	...	...	T	...	...	...
0-8-4. . .	T	...	...	...	T	...	...	...	...	...	...	...	T	...	...	...
2-8-0. . .	...	L	...	...	T	L	...	L	T	L	...	L	...	L	...	...
2-8-2. . .	T	L	...	...	T	L	...	L	...	L	...	..	...	L	...	L
2-8-4. . .	...	...	...	...	...	...	...	L	...	L	...	...	T	L	...	...
4-8-0. . .	T	L	T	...	...	L	...	L	...	L	...	L	...	...	...	...
4-8-2. . .	...	...	...	...	...	L	T	L	...	...	...	...	..	...	...	...
4-8-4. . .	T	...	...	...	...	...	T	...	...	...	T	...	T	...	...	...
0-10-0 . . .	...	...	...	...	T	L	T	L	T	...	...	...	...	...	...	...
0-10-2 . . .	...	...	...	...	...	...	...	...	...	...	..	...	...	...	...	...
0-10-4 . . .	...	...	...	...	...	...	...	...	...	...	...	..	...	...	...	..
2-10-0 . . .	...	L	...	...	T	L	...	...	...	...	...	...	...	...	...	...
2-10-2 . . .	...	...	...	...	...	L	...	...	...	...	...	...	...	...	...	...
2-10-4 . . .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
4-10-0 . . .	...	...	...	...	...	...	...	...	...	..	...	...	...	...	...	...
4-10-2 . . .	...	...	...	...	...	...	T	...	...	...	...	...	...	...	...	...
4-10-4 . . .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
2-12-2 . . .	...	...	...	...	T	...	T	...	...	...	...	...	...	...	...	...

TABLE 22.

Height to the top of roof of vehicles of different gauges.

Gauge.	RAILWAY.	TYPE OF VEHICLE.	External height of vehicle.
1 m. 676.	Argentine State	President's saloon.	4 m. 267
	Central Argentine Railway . .	Sleeping car	4 m. 166
1 m. 600.	Central Brazilian Railway . .	Dining car	4 m. 147
1 m. 435.	Illinois Central Railway. . .	Suburban coach	4 m. 334
	Pennsylvania Railroad . . .	Steel day coach	4 m. 280
	International Sleeping Car Company.	Saloon	4 m. 027
	Prussian State.	Saloon	4 m. 060
	London North Western Railway	Saloon	3 m. 848
1 m. 000.	Indian State Railways . . .	Royal train	3 m. 397
	Brazil Railway.	Standard rolling stock . . .	3 m. 715
	Leopoldina Railway	Sleeping car	3 m. 685
0 m. 762.	Leek & Manifold Light Railway	Typical vehicles	3 m. 050
0 m. 610.	Gwalior Light Railways. . .	Typical vehicles	2 m. 770

It is also said that it only requires a very slight difference between the level of the rails to cause the vehicles of narrow gauge railways to turn over. Table 23 gives the superelevation necessary to produce this effect :

TABLE 23.

Gauge.	1 m. 674	1 m. 435	1 m. 0675	1 m.	0 m. 90	0 m. 75	0 m. 60
Height of the centre of gravity above rail level.	Difference of level of rails necessary to cause vehicle to overturn.						
1 m. 00.	1.074	0.840	0.502	0 442	0.367	0.260	0.235
1 m. 50.	0 866	0.618	0.360	0.315	0.260	0.180	0.162

Corridor vehicles for a metre gauge track have compartments with seating accommodation for three passengers on each seat, as in the case of standard gauge vehicles. Vehicles for lesser gauges have as a rule two places instead of three. In spite of this fact, however, the tare per passenger is less in the case of smaller gauges.

Sufficient use is not made of the extra width which might be obtained by the use of the broad gauge, because the loading gauge is not very much larger than that for standard gauge

vehicles. This gauge offers no advantage, except it may be as regards stability, of which there is a large margin on the safe side, even when the line is ballasted with earth, as in the Argentine, where stone ballast is very expensive.

The influence of gauge is especially felt in the case of vehicles « de luxe ». However, very excellent sleeping cars have been placed on narrow gauge railways. Those on the *Leopoldina Railway* (Brazil) have even the beds arranged

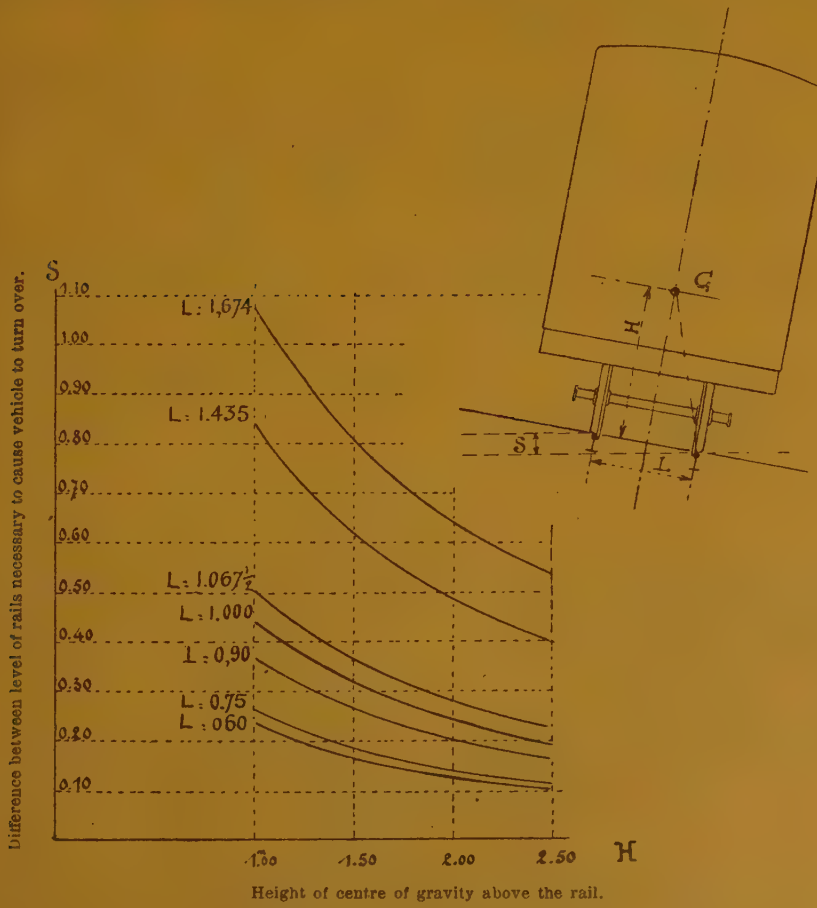


Fig. 10. — Influence of the gauge on the stability of rolling stock.

accross the vehicle in accordance with European practice, but the dimensions of the compartments are smaller.

The *Antofagasta and Bolivia Railway*, which is of 2′ 6″ (0 m. 76) gauge, employes sleeping cars and dining cars of our international type.

3. Wagons. — High capacity wagons are used on narrow gauges of which the

tare is proportionally considerably less, and this is an advantage for the narrow gauges. This type of vehicle is not open to the same disadvantages as the passenger stock, in which the degree of comfort is less than in the case of lines of broader gauge; the stability of the wagons is sufficient, and their capacity is comparable with that of the vehicles of the larger lines.

Moreover, trains may be worked which are no less as regards tonnage than those found on the latter. For instance, the heavy *Mallet* or *Garratt* engines in South Africa haul trains equal to 1 600 English tons.

The following examples show the capacity of certain wagons on narrow gauge lines :

1 m. 067 (3′ 6″) gauge :

South African Railways. — Wagons of 45 t. capacity with a tare weight of 18 t. Useful load equals 71% of the total weight.

1 m. (3′ 3 3/8″) gauge :

Central of Brazil Railway. — Wagons of 40 t. capacity with a tare weight of 17 t. Useful load equals 70% of the total weight.

0 m. 76 (2′ 6″) gauge :

Antofagasta and Bolivia Railway. — Capacity 20 t.; tare 6 t. Useful load 77 %.

0 m. 61 (2′) gauge :

British India. — Capacity 18 1/2 t.; tare 7 t. Useful load 73 %.

It will be seen that all these wagons carry a useful load of more than 70 % of the total weight.

Utilisation of rolling stock — One often finds a ratio of 1 : 2 1/2 or 1 : 3 between the tare and the load of wagons for narrow gauges as compared with those for standard gauge.

The *Victoria Report* estimates (p. xvi) that the proportion of tare to the useful load of a train, including the engines is as 1 : 1 for the broad gauge, and 1 : 2.5 for the 2′ gauge.

According to the same report, a wagon of 10 t. capacity weighs 3 t. for the 2′ or 2′ 6″ gauge, and 8 t. for the standard gauge.

Mackay gives the weights of 1 1/2 to 2 and 1 1/2 to 4 1/2 respectively for a 6 t. wagon of the above gauges.

The high sided wagons of the *Znin District* weigh 2.1 t. for a capacity of 7 1/2 t. or a ratio of 1 : 3.

On the *Darjeeling Railway*, the ratio is 1 : 3 1/2 (Mackey).

Finally, Liebmann gives the following average tares :

Table 24.

Gauge.	1 m. 435	1 m.	0 m. 750	0 m. 600
Passenger stock (per passenger)	318	165	150	120 kgr.
Covered wagons (per tonne).	750	570	510	490 kgr.
Open wagons (per tonne).	600	500	480	450 kgr.

CHAPTER VII. — C) INFLUENCE OF GAUGE ON OPERATION.

It is not possible to deal with this question from every point of view, but we will make a certain number of observations on subjects which may be grouped as follows :

1. Speed of trains;
2. Passenger traffic;
3. Freight traffic;
4. Cost of upkeep, excluding rolling stock;
5. Cost of upkeep of rolling stock and consumption or fuel, lubricants, etc.;
6. Working expenses;

which we will follow by paragraphs of a more general order :

7. Comparison of various sections of line of different gauges belonging to the same railway system;
8. Conclusions.

1. Speed of trains. — On narrow gauge lines, the maximum speed of trains is lower.

It has been stated that this is a point of inferiority; but this statement requires qualification. As a matter of fact, this implies that narrow gauge should be used in cases where it is capable of fulfilling the demands which may fairly be made upon it, and not as a substitute for a gauge which is more suitable for the purposes required.

However, we give below the maximum speeds attained in the Argentine on lines of the three gauges for the longest non-stop runs made in 1922. We have purposely taken examples from this country, because in it one finds comparable lines constructed to the broad, standard and narrow gauges. (See table 25.)

TABLE 25.

Speed of passenger trains in the Argentine on lines of each of the three gauges.

Gauge.	COMPANY.	LENGTH OF RUN.	Time of departure.	Duration of run.	Total kilometres.	Kilometres per hour.
1 m. 67	Central Argentine	Retiro-Peyrano-Rosario.	18.00	4 h. 30	352	78.2
		Retiro-Rosario . . .	8.00	4 h. 30	303	67 (1)
		Galvez-Retiro	12.00	2 h. 05	117	56
1 m. 67	F. C. del Sur . .	Constitucion-Temperley.	Numerous trains.	0 h. 18	17	57
1 m. 67	F. C. Pacifico. .	Palermo-José C. Paz .	Numerous trains.	0 h. 40	40	60
		Palermo-Mercedès . .	8.44	1 h. 56	106	55
		La Paz-Mendoza . . .	2.38	2 h. 52	140	49
1 m. 435	Central de B. A.	F. Lacroze-Pereyra . .	Numerous trains.	0 h. 30	17	34
1 m. 435	F. C. Entre Rios.	Basavilbaso-S. Salvador.	2.00	3 h. 02	112	37
1 m.	Meridiano V°. .	La Plata Etcheverry. .	9.00	0 h. 26	17	40 (1)

(1) This includes an additional stop of five minutes for the *Central Argentine Railway* and of one minute for the *Cinquième Méridien Railway*.

A better idea will be obtained as regards the possibilities of the narrow gauge from the point of view of speeds attained in practice by a glance at table 26, which gives particulars as regards various narrow gauge railways. It will be seen that although the narrow gauge may not be intended for high speed, yet fairly high speeds can be realised.

TABLE 26.

Speed of passenger trains on narrow gauge railways.

Gauge.	COUNTRY.	Speed in kilometres per hour.	Remarks.
1 m. 067	Java (State)	70	Including stops.
1 m. 067	New Zealand (State)	63	Non-stop.
1 m. 067	South African Railways	60	— —
1 m. 067	Japan (State)	60	— —
1 m. 000	Brazil (Leopoldina Railway)	60	— —
0 m. 610	India (Bengal Nagpur Railway)	36	— —

2. **Passenger traffic.** — The space allotted to each passenger is less in the case of narrow gauge lines, but otherwise does not differ from that provided on standard gauge lines. It may be mentioned in passing that a large number of narrow gauge railways overseas, use rolling stock in which are three benches arranged longitudinally. This is the practice in Japan, Java and in South Africa.

3. **Freight traffic.** — Gauge has only a small influence on the transport of freight.

4. **Cost of upkeep, excluding rolling stock.** — The question of relative cost of upkeep of different narrow gauge lines is a very controversial topic. It is very difficult to establish comparisons, because no two lines are operated under identical conditions.

A comparison of expenses between lines of the same gauge are also open to criticism; we will therefore merely give a few interesting examples. (See table 27.)

Per unit of transport, the cost of maintenance on the *Mecklenburg-Pomeranian Railway* of 0 m. 60 gauge, is only 60 % of the average cost for the four principal lines of 1 m. gauge.

The figures in table 28 are extracted from the statistics for the narrow gauge as quoted by Zezula (1903-1904).

5. **Cost of upkeep of rolling stock and consumption of fuel, lubricants, etc.** — As in the cost of permanent way upkeep, these figures can only be given as a rough guide. They vary in accordance with the rolling stock, with the traffic and with a host of other causes, some of which it is true are affected by the gauge. Here again we will confine ourselves to giving a few typical examples. (See tables 29 to 33.)

TABLE 27.

Cost of upkeep, excluding rolling stock, for lines of 0 m. 60 and 1 m. (1' 11 5/8" and 3' 3 3/8") gauge in Germany for 1906.

	1 m. gauge.					0 m. 60 gauge.
	Altena District railway.	Feldabahn.	Flensburg-Kappeln.	Zell-Todtnau.	Average for the 1 m. gauge.	Mecklenburg-Pomeranian.
	Marks.	Marks.	Marks.	Marks.	Marks.	Marks.
Per kilometre of track . . .	1 152	214	433	397	549.00	225
Per 1 000 useful engine kilometres	270	64	102	133	142.00	95
Per 1 000 units of transport .	28	6	13	12	14.75	9

TABLE 28.

Gauge.	RAILWAY.	Cost per axle-kilometre.	
0 m. 600.	Mecklenburg-Pomeranian	0.30 pfennig.	0.375 centime
0 m. 600.	Feldabahn	0.46 —	0.575 —
1 m. 000.	Lahrer Bahn	0.61 —	0.763 —

TABLE 29.

Cost of upkeep of rolling stock for lines of 0 m. 60 and 1 m. (1' 11 5/8" and 3' 3 3/8") gauge in Germany.

	1 m. gauge.					600 mm. gauge.
	Altena District railway.	Feldabahn.	Flensburg-Kappeln.	Zell-Todtnau.	Average for the 1 m. gauge.	Mecklenburg-Pomeranian.
	Marks.	Marks.	Marks.	Marks.	Marks.	Marks.
Per kilometre of track . . .	661	164	314	235	344.00	193
Per 1 000 useful engine kilometres	154	50	73	79	89.00	82
Per 1 000 units of transport .	16	5	9	7	9.25	8

The statistics given by Zezula, quoted above, are as follows :

TABLE 30.

Gauge.	RAILWAY.	Expenses per axle-kilometre.	
0 m. 600 . . .	Mecklenburg-Pomeranian	0.54 pfennig.	(0.675 centime).
1 m. 000 . . .	Lahrer Bahn	0.51 —	(0.637 —).
1 m. 000 . . .	Feldabahn	0.66 —	(0.825 —).
1 m. 000 . . .	Walhallabahn	0.68 —	(0.85 —).
1 m. 000 . . .	Rhætian Railways	0.78 —	(0.975 —).

TABLE 31.

Consumption of coal per useful engine kilometre (1906).

For 0 m. 60 gauge.		For 1 m. gauge.	
Festiniog Railway	4.22 kgr.	Feldabahn	6.50 kgr.
Mecklenburg-Pomeranian	6.07 —	Flensburg-Kappeln	6.05 —
Paris Exhibition Railway	3.91 —	Indian Railways	8.00 —

TABLE 32.

Consumption of coal per 1 000 units of transport.

For 0 m. 60 gauge.		For 1 m. gauge.	
Mecklenburg-Pomeranian	590 kgr.	Zell-Todtnau	730 kgr.
		Mannheim-Heidelberg	750 —
		Karlsruher Lokalbahn	530 —
		Flensburg-Kappeln	750 —
		Average	690 —

TABLE 33.

Fuel, cleaning and lubricants, Germany (1906).

	1 m. gauge				600 mm. gauge.
	Altena District Railway.	Feldabahn.	Flensburg-Kappeln.	Average of the 1 m. gauge.	Mecklenburg-Pomeranian.
	Marks.	Marks.	Marks.	Marks.	Marks.
Per kilometre of track	1 100	572	441	704.00	357
Per 1 000 useful engine kilometres . . .	257	173	103	178.00	151
Par 1 000 units of transport	27	16	13	18.55	14

6. **Working expenses.** — We will confine ourselves to giving a few examples from which it will be clearly seen that the working expenses decrease with the gauge, but we are not prepared to state what effect this may have, as these figures depend too much on local circumstances. (See tables 34 to 36.)

TABLE 34.

Working expenses per kilometre for Prussian secondary railways (1).

	Traffic department.		Balance.	Cost of construction per kilometre.
	Receipts.	Expenses.		
	Marks.	Marks.	Marks.	Marks.
Standard gauge	4 523	2 817	1 706	79 553
1 m. gauge	4 121	3 049	1 072	52 310
0 m. 75 gauge	2 022	1 704	318	37 301
0 m. 60 gauge	2 023	1 594	429	22 254

In 1902, the expenses per kilometre were as follows :

TABLE 35.

Gauge	1 m. 435	1 m. 000	0 m. 750	0 m. 600
Ratio	1.8	1.9	1.07	1

TABLE 36.

Working expenses of lines of 0 m. 60 and 1 m. (1' 11 5/8" and 3' 3 3/8") gauge in Germany.

	1 m. gauge.									0 m. 60 gauge.	
	Feldabahn.	Altena District railway.	Eckernförde-Kappeln.	Flensburg-Kappeln.	Kaiserberger-Talbahn.	Gernrode-Harzgerode.	Weimar-Tastenberg.	Zell Todtnau.	Average for the 1 m. gauge.	Mecklenburg-Pomeranian.	Ratio of 0 m. 60 gauge to 1 m. gauge.
	Marks.	Marks.	Marks.	Marks.	Marks.	Marks.	Marks.	Marks.	Marks.	Marks.	Marks.
Per kilometre of track. .	2 674	6 094	2 413	3 276	5 241	3 401	1 935	3 412	3 556.00	1 619	45 %
Per 1 000 useful engine kilometres.	809	1 424	905	769	1 174	1 176	734	1146	1 017.10	687	67 1/2 %
Per 1 000 units of transport.	75	148	130	95	104	88.80	124.9	106	109.00	64	59 %

(1) Memorandum laid before the Prussian Chamber 11 March 1904.

For lines of 0 m. 60 gauge, the working expenses as a ratio of that for the 1 m. gauge were as follows :

TABLE 37.

Per kilometre of track	45.0 °/₀
Per 1 000 useful engine kilometres .	67.5 °/₀
Per 1 000 units of transport . . .	59.0 °/₀

7. **Comparison of various sections of line of different gauges belonging to the same railway system.** — It is interesting to note, not only the differences in practice of operation and construction which are met with on railways of different gauges, but also those which obtain on various sections of one and the same system which possesses lines of different gauges. Table 38 gives a few examples.

TABLE 38.

RAILWAY.	1 m. 676	1 m.	0 m. 76
Maximum running speed.			
Madras & Southern Mahratta Railway	96 km.	48 km.	...
Bombay Baroda & Central India Railway	112 km.	64 km.	...
South Indian Railway	80 km.	64 km.	...
Maximum weight of passenger trains.			
Bombay Baroda & Central India Railway	462 t.	396 t.	...
Bengal Nagpur Railway.	508 t.	...	220 t.
South Indian Railway	285 t.	264 t.	152 t.
South Australian Government Railways	356 t.	366 t. (1 m. 067)	...
Maximum weight of freight trains.			
Madras & Southern Mahratta Railway	1 525 t.	622 t.	...
Bombay Baroda & Central India Railway	1 626 t.	752 t.	...
Bengal Nagpur Railway.	1 524 t.	....	508 t
South Indian Railway	711 t.	508 t.	152 t.
South Australian Government Railways	710 t.	640 t. (1 m. 067)	...

8. **Conclusions.** — We will quote the conclusions arrived at by Mr. Dawson (1), who deals with the railways laid in British India to broad gauge (1 m. 676), to 1 m. and to narrow gauge (0 m. 60 or 0 m. 76), as these remarks have a general application.

For lines in easy country which only carry light traffic, there is a decided advantage in favour of the narrow gauge, from an operating point of view, up to the point at which the limited capacity of the line is reached.

(1) Paper read 15 November 1921 at the Institution of Civil Engineers, London, entitled : *The Indian Railway Gauge Problem.* Mr. Dawson was chief engineer to the « Indian Railway Board ».

Where works of considerable magnitude are necessary in constructing the line, the economy obtained by the narrow gauge is negligible.

The maximum speed permissible varies with the gauge.

For similar average receipts per kilometre, the coefficient of operation increases as the gauge decreases. Up to a definite point, the coefficient decreases as the receipts increase.

The ratio between the capital expenditure and the gross receipts is the same, irrespective of the gauge.

Finally, we give an interesting comparison of all the various elements, both as regards construction and operation, for two mountain lines which are both situated in Switzerland, the one of standard gauge and the other of 1 m. gauge. These are the St. Gothard Railway and the Rhætian Railways. The particulars given refer to pre-war operation, which are more recently. We therefore have given those which relate to a few years back, because the Rhætian Railways had not at that time constructed the branch lines, which would have spoilt the comparison if one had taken figures referring to a more recent year. (See table 39.)

TABLE 39.

Comparison of particulars of two lines in mountainous country one of 1 m. 435 (4' 8 1/2"), and the other of 1 m. (3'3 3/8") gauge for the year 1905.

		St. Gothard Railway.	*Rhætian Railways.*
Gauge	Millimetres	1 435	1 000
Length of line	Kilometres	273.5	173.2
Total rise above datum level	Metres	2 562.72	3 065.75
Minimum radius of curves	—	250	100
Length of tunnels	—	46 148	17 835
On rising gradients	Per cent	55.9	58.1
On falling gradients	—	24.8	29.0
In tunnels	—	17.0	10.3
On viaducts	—	2.3	2.6
Average gradient	Millimetres per metre.	9.3	17.8
Maximum gradient	— —	27.00	45.00
Train-kilometres		4 636 803	915 383
Axles per kilometre	Number	421 185	73 840
Trains running each day over whole length of line	—	36.9	13.5
Axles per train	—	25	13.9
Receipts per passenger-kilometre	Pfennigs	4.90	6.56
— per tonne-kilometre	—	6.25	24.98

TABLE 39 (*To be continued*).

		St. Gothard. Railway.	*Rhætian Railways.*
Receipts and additional takings :			
Passenger traffic	Per cent	39.9 + 4.4	43.5 + 1.5
Freight traffic	—	55.7	55.0
Total receipts per kilometre in operation	Marks	74 216	20 407
Expenses :			
General expenses	Marks	1 857	544
Maintenance and inspection of permanent way	—	7 114	3 558
Rolling stock	—	10 749	1 368
Locomotive and workshop expenses	—	17 701	4 279
Sundry expenses	—	4 990	732
Total expenses per kilometre	—	42 411	10 681
Profit per kilometre	—	31 805	9 726
Profit per axle-kilometre	Pfennigs	7.55	13.12
Percentage cost of operation	Per cent	57.15	52.34

(*To be continued.*)

[656 .256 (.42)]

A new system of track-circuiting for railways.

Figs. 1 to 6, pp. 72 to 76.

(*Railway Gazette.*)

By the courtesy of Mr. C. J. Brown, C. B. E., engineer, London & North Eastern Railway (Great Northern section), we were recently afforded facilities for inspecting at Retford, on the London & North Eastern Railway main line, an installation of new track-circuiting system, operating in the block section between Grove Road and Retford station. The details of the system were explained to us by Mr. F. Downes, Telegraph Superintendent, Great Northern section, London & North Eastern Railway, Retford, who, with his staff, was responsible for equipping this experimental installation. Mr. A. E. Hudd, of the Automatic Telephone Manufacturing Company Limited, Liverpool, the manufacturers of the apparatus, was present, and provided us with further useful information respecting it.

The term « transient » applied to track circuits is used to distinguish the ordinary continuously energised track circuit from one in which current is only applied to the track rails momentarily. Track circuits now play such an important part in railway signalling that there are very few new installations of signalling on railways today in which track circuit does not form the basis on which the whole scheme of signalling depends.

The ordinary form of continuously energised track circuit in which the current is fed to the track from primary or secondary batteries, is strictly limited in its application owing to the large amount of battery energy which is wasted in the track itself before it reaches the relay. In order to overcome this inherent defect and thereby increase the range of application, the transient track circuit has been devised.

The usual, and indeed the main function of any track circuit, is to ensure that a lever operating a signal controlling a section shall not be operated unless the section is clear. It would appear, therefore, that by confining the application of a track circuit to « control » purposes only, there is no need for the track circuit to be continuously energised. So long as means are provided, a proving current may be swept through the track at the moment of pulling the signal lever. Such being the case, the point to be decided is whether it is necessary for a controlling track circuit to be continuously energised at all, and whether momentary energisation is alone sufficient.

For some years past the Automatic Telephone Manufacturing Company have been working on the problem of providing a safe and reliable method of applying transient currents to a track circuit. Mr. Brown, also, for some time had been considering the possibility of employing transient currents, but realised the necessity of proving the track at the moment of pulling the signal lever, as mentioned above. This essential feature having been satisfactorily provided for as the result of the railway company's experiments, was incorporated in the original scheme of the Automatic

Telephone Company and Mr. A. E. Hudd.

At a first glance, it might appear that the only thing necessary would be simply to press a button and apply current direct from the batteries to the track when required, and we understand such track circuits were installed on the Great Northern Railway at Hornsey and Enfield as far back as the year 1898. These circuits worked well, but as permanent positive indications were considered necessary this transient principle of working was abandoned pending the development of a system embodying this feature. This arrangement however is not considered a safe one, as a track relay normally de-energised may be picked up by a stray direct current in the track rails. The only manner, therefore, of ensuring safety under all conditions, is to make use of alternating current instead of direct, and it is upon the use of alternating currents from primary batteries that the transient track circuit system is based.

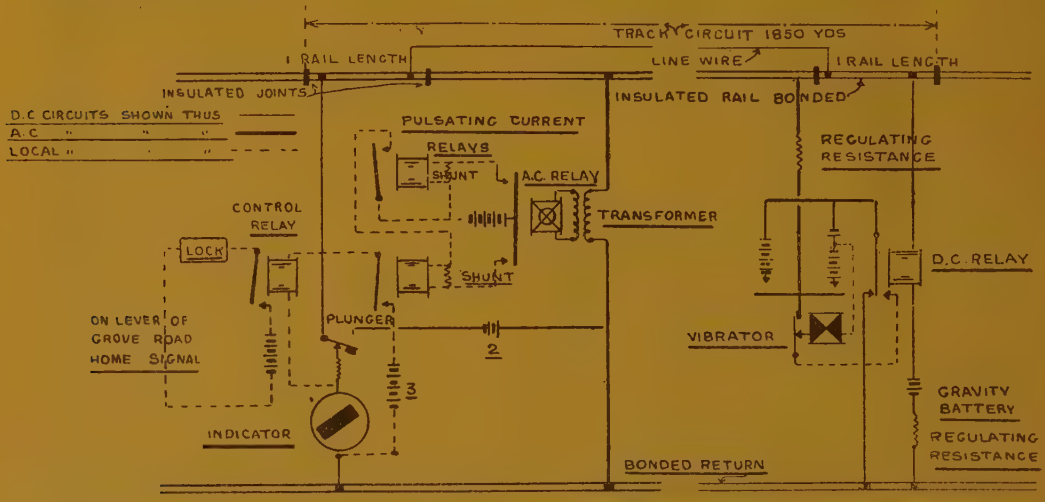


Fig. 1. — Schematic diagram of alternating current transient track circuit, as installed in the down main line. Grove Road to Retford South, London & North Eastern Railway.

Apart from the safety features of alternating current, it is found that it is possible to devise a relay which would respond extremely to weak alternating currents, and thereby greatly increase the length of the track circuit. In fact, with this system, it may now be found possible to have a track circuit two to three miles in length without making use of a cut section.

It would appear, therefore, that the system not only saves money in the cost of battery maintenance, but also in the capital cost of an installation where the total length of a track-circuited section is over half a mile in length.

The ordinary continuous track circuit requires a cut or relaying section every 600 yards on the average, unless heavy capacity batteries are employed, whereas the transient track circuit such as would be used for intermediate block working, for instance, where the section may be two miles in length, would eliminate the provision of several cut sections.

The maintenance of such cut sections becomes a very serious item in out of the way places, which would generally

be the case where intermediate block working is required on main lines in this country, and as the batteries used for the transient track circuit have only current taken from them approximately one-thousandth of the time which ordinary track circuit batteries use, it follows that the maintenance of such batteries would materially be reduced.

The figure of merit of a track circuit from a safety point of view is one which represents the highest possible « train shunt » value. Long, direct-current, continuously-energised track circuits are notoriously bad in this respect, principally owing to the fact that in order to obtain good train shunts it is necessary to have a considerable amount of dead resistance interposed between the battery feed to the track. The energy dissipated by this feed resistance is quite considerable, and in a great number of track circuits of the ordinary type where a high value of train shunt is desirable, the amount of energy thus wasted forms a large proportion of the whole. When current applied to a track circuit, however, is only momentary, it is obvious that one can afford to apply a considerable current through a large feed resistance, and in so doing obtain a high value of train shunt. The result is that the train shunts obtainable on transient track circuits may, in every instance, be considerably higher than can be obtained on a continuous track.

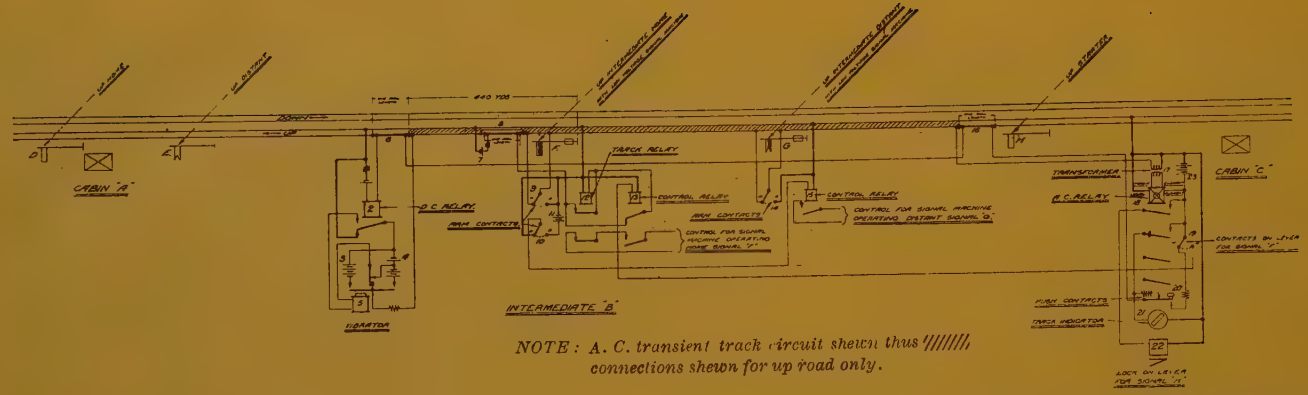
In September 1922 the Great Northern Railway placed an order for the equipment of an experimental section of track circuit on the transient system, and on 9 October the experimental track was installed on the down main line south of Retford, the length of the track being 930 yards. A series of careful tests was applied from time to time, and some modifications were made in the apparatus. Satisfactory results were then obtained, and it was decided on 15 November 1922, to extend experimentally the track to 1 850 yards. It was thought at first that the extension of the track might reduce the value of train shunt, but such was found not to be the case.

After some further experience, it was decided to bring the transient track into actual use, and a lever lock was therefore provided controlling the down home signal at Grove Road signal box, Retford, the lever lock being directly controlled by the transient track circuit. A normal indication was provided showing the state of the track after the last train had cleared, and a push-button arrangement was also provided in the signal cabin instead of the usual catch-handle contact. The whole arrangement was brought into use on 9 March 1923, and has worked satisfactorily from that date. The one failure of the track-circuit relay to pick up when the track was cleared was caused by a heavy thunderstorm, which necessitated a slight increase in the voltage applied at the feed end of the track.

The following may be taken as briefly explaining how the system operates:

During « track-clear » periods current circulates from battery No. 1 through D. C. relay (current insufficient to energise this) through single rail length, along line wire to control end of track, thence through single rail length and track indicator to return rail. The current available holds the indicator in the clear position, it is not sufficient to deflect it thereto.

To pull off the Grove Road signal the plunger must be depressed, this has the effect of connecting battery No. 2 in series with battery No. 1 in the D. C. circuit. The additional current available results in the energisation of the D. C. relay and the vibrator is actuated. When the plunger is released the armature of the D. C. relay is no longer attracted, but as the oscillating member of the vibrator has considerable inertia, it continues to vibrate for some



NOTE: A. C. transient track circuit shewn thus ////////, connections shewn for up road only.

NOTE: The interlocking in cabin "C" to be arranged so that the signals leading up to starter "H" cannot be lowered a second time unless the lever controlling signal "H" has been put normal.

Fig. 2. — Transient track circuit system : Intermediate working with push contact control.

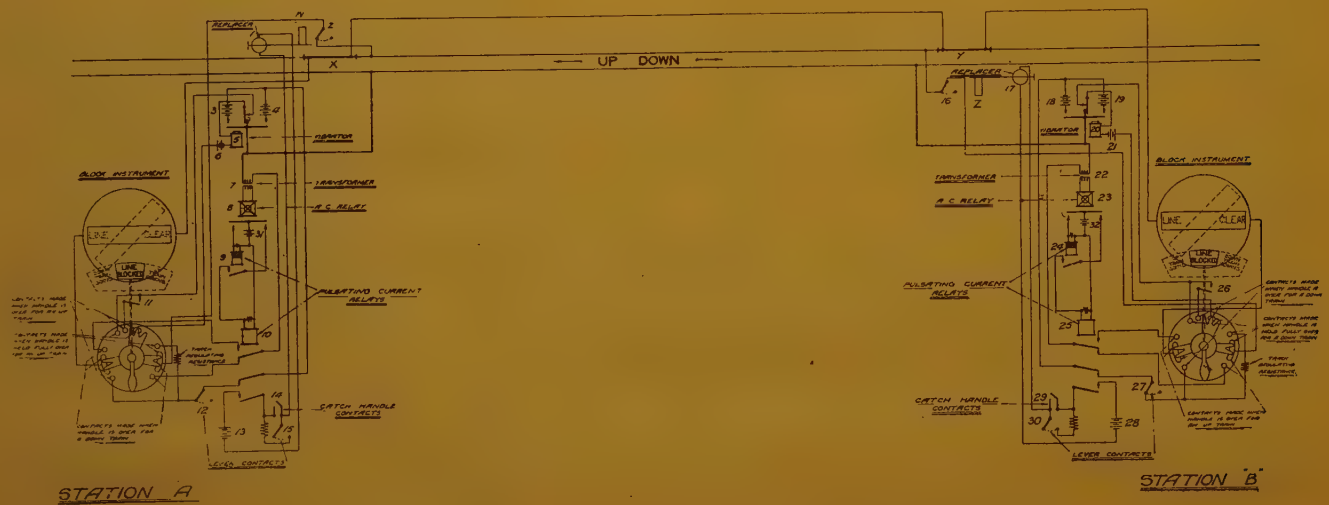


Fig. 3. — Arrangement of transient track circuit system for single line working.

DATE.	Ballast resistance.			Regulating resistance.	Current flowing normally, m/a.	Train shunt, single rail section.		Prevent pick up shunt A.C. track.	Weather.	*Remarks.*
	Entering end.	Exit end.	A.C. section.			Entering end.	Exit end.			
	15 yards.	15 yards.	1 820 yards.	A.C. feed						
	Ohms.	Ohms.	Ohms.	Ohms.		Ohms.	Ohms.	Ohms.		
1923.										
9 March.	...	...	..	...	...	...	...	...	...	Indicator connected.
12 — ..	...	...	...	0.5	37	14.95	...	0.85	Fine.	
19 — ..	...	...	..	0.5	37	17.4	...	0.6	Fine.	
21 — ..	...	..	...	2.0	...	...	...	...	...	Locks connected. Dry cell batteries renewed.
26 — ..	...	..	...	2.0	36	17.4	...	0.65	Fine.	
9 April...	...	...	...	2.0	30	14.5	...	0.9	Fine.	
12 — ..	...	...	...	0.5	...	...	...	...	...	Track failed owing to very heavy rainstorm. Series regulating resistance in A.C. feed reduced from 2 ohms to 0.5 ohm when regular working resumed.
16 — ..	..	...	...	0.5	30	13.7	...	0.15	Fine after heavy rain.	One gravity cell replenished.
16 — ..	...	...	...	2.0	30	13.7	..	0.65	Ditto.	Track regulated.
23 — ..	...	...	...	2.0	27	11.4	..	0.7	Fine.	One gravity cell replenished.
30 — ..	...	...	..	2.0	28	12.35	...	0.85	Fine.	
8 May....	...	...	...	2.0	28	13.8	..	1.0	Fine.	
14 — ..	...	...	...	2.0	31	13.0	..	1.5	Fine after rain.	
22 — ..	...	...	...	2.0	38	14.2	4.2	2.0	Raining.	
22 — ..	...	...	...	1.5	...	...	...	1.0	...	
28 — ..	173	96	1.08	1.5	40	13.9	...	1.4	Raining.	
4 June ...	...	...	...	1.5	39	13.1	...	1.1	Fine.	
11 — ..	...	..	...	1.5	34	14.2	..	0.6	Fine.	
18 — ..	...	..	...	1.5	35	11.0	...	0.8	Raining.	

History and characteristics of transient A. C. track circuit, 1 850 yards long, installed in block section, Retford South to Grove Road, indicating in Grove Road box and controlling lock on lever of Grove Road box home signal.

« Line clear » cannot be pegged on block to rear box until lever of Grove Road home signal has been replaced to danger position.

Fig. 4. — Instruments in Grove Road signal cabin at south end of section.

Fig. 5. — Cabinet in Grove Road signal box, containing A. C. transient relay (left-hand side), neutral D. C. repeater relay, track transformer and local battery for A. C. relay and lever lock on starting signal.

Fig. 6. — Cabinet at feed end of transient track circuit, containing A. C. vibrator, track feed battery (dry cells), and indication battery (Daniell cells).

seconds after the current in the vibrator coils is interrupted. During the time the vibrator continues to function alternating E. M. F. is impressed across the track rails, causing alternating current to be transmitted to the transformer primary coils at the control end.

The secondary winding of the transformer is connected directly to the A. C. relay, the armature of which oscillates, causing the pulsating current relay armatures to be attracted, when current will flow from battery No. 3 through local circuit including control relay and indicator. The indicator (which momentarily dropped to « track occupied » when the plunger was depressed) will now be deflected to « track clear », and the control relay will be energised for about three seconds, during which time the lock on the lever of the home signal will be free. When the track is occupied, and a train enters the track circuit at the south of Grove Road end, the indicator is shunted and assumes by gravity the « track blocked » position. Upon the short rail length at the exit end becoming occupied, the D. C. relay is actuated and the vibrator oscillates. When the wheels of the last vehicle clear the track, the armature of the D. C. relay falls and completes the circuit through the bottom contact. The vibrator continues to oscillate for a short time due to inertia. Alternating current is transmitted to the A. C. relay, which operates and causes a sufficiently strong current to flow in the coils of the indicator to deflect it to the « track clear » position.

The above table, supplied by Mr. Downes, shows particulars of the working of the system from the date of installation until the latter part of June 1923.

The transient track circuiting system is adaptable to railways on the widest scale, and opens the way to considerable possibilities of development in automatic signalling by bringing costs within reasonable figures.

[385 .524 (.73)]

The Ford plan of employee participation.

(*Railway Review.*)

The plan of employees' investment certificates on the Detroit Toledo & Ironton Railroad, which has been authorized by the Interstate Commerce Commission, as noted in these columns last week, represents the extension to this railroad of a profit-sharing plan which has been operated for four years by the Ford Motor Company. The application for sanction of the plan has been pending before the Interstate Commerce Commission for almost a year. As now authorized, the Detroit Toledo & Ironton is given permission to issue $1 000 000 of certificates of indebtedness to its employees, in denominations of $100, $500 and $1 000. The commission's order provides that « the proceeds thereof, or the money received in payment therefor, to be used solely for capital purposes ». But the primary purpose of the plan is to afford opportunity to the employees to participate in the profitable operation of the property. But unlike the policy followed in the Ford Motor Company's investment plan, a fixed rate of interest cannot be guaranteed on Detroit Toledo & Ironton Railroad certificates, due to laws governing railroads and rulings of the

Interstate Commerce Commission. The plan of issuing the certificates is briefly as follows :

Detroit Toledo & Ironton Railroad employees, 21 years of age or over, may invest an amount not exceeding one-third of their pay, which must be deposited within three days after such salary or wages are received from the railroad. However, it has been arranged that employees may invest one-third of wages received from the company since 1 October. Payments may be made at the regular pay offices or with the company's ticket agents, when pay envelopes or salary checks should be displayed with employment credentials.

Upon receipt of such deposits and credentials, cards will be issued, showing badge number, date and amount paid. When an employee's card shows a balance of $100, he may have this sum transferred to an investment certificate.

It is not compulsory that a payment be made on every pay day, or that the amount be the same each time. Regular payments, however, are encouraged, which may be one dollar or more. When an employee does not make a payment within the three-day limit after pay day, he loses that opportunity of using that part of his pay to apply for the purchase of a certificate; he cannot make it up out of his next pay.

Investment certificates are non-negotiable and non-assignable, and are invalid when held by other than an employee of the Detroit Toledo & Ironton Railroad, except in case of death. In such instance, the amount with accrued interest becomes payable at once to the proper representative of the deceased.

It is the intention of the company that money intrusted to it shall be always at the employees' disposal, and that in case they wish to withdraw it for any reason, they may be able to get it without delay or inconvenience. Deposits may be withdrawn by presenting order and credentials at pay offices or to any ticket agent, and signing receipt. Certificates may be redeemed by endorsing on back and depositing at pay offices or with ticket agents, to be forwarded to the treasurer's office at Detroit. Check, including interest, will be sent to the agent with whom the certificate was left. As an emergency safeguard, the company reserves the right to demand thirty days' notice in writing of the employees' intention to demand payment.

In case of leaving the service of the railroad or in case of discharge, an employee's deposits or certificates become payable at once in cash. This is subject, however, to the company's rule requiring thirty days notice of payment.

The money received by the railroad in payment fort certificates is to be accounted for as a separate fund, and is to be invested in such securities as the board of directors may determine, or is to be used by the railroad in making additions and betterments or for any other expense in connection with the operation of the railroad. Income from investments of the fund is to be separately kept and accounted for, and, together with interest on such part of the fund as may be used for making additions and betterments to the property, or for other corporate purposes, is to be applied on the return to certificate holders.

A return is to be paid semi-annually upon the certificates at such rate as may be determined by the board of directors. This return is to be paid from income on investments of the fund, from interest on such part of the fund as may be used by the railroad as above stated, and from special appropriations of net earnings, if any, after reservation has been made from net railway operating income in accordance with the provisions of section 15*a* of the interstate commerce act, such appropriations, in no event, to exceed 25 % of net earnings after making such reservation. By

the terms and conditions made a part of the employee's application for certificates, the return is to be paid only if, in the discretion of the board of directors, the earnings of the railroad warrant such payment.

The Interstate Commerce Commission, in its opinion, discusses at some length the general features of the employee's participation in a plan of this kind. We quote from the commission's report as follows :

The Commission's Opinion.

« Since payment of the return is not guaranteed by the applicant, but is entirely within the discretion of its board of directors, a failure to pay it would in no way involve the applicant. The only liability to be incurred by the applicant through the issue of the proposed certificates is to pay the principal thereof at the expiration of thirty days after notice from the employee of his intention to demand payment. In the last analysis the certificates are merely short-term obligations, bearing such return, within the limits stated above, as the board of directors may see fit to pay, and in addition, entitling the employee to participate in net earnings. The only novel feature is the provision as to return.

« It is doubtful whether the applicant could use the income from investments made with the money received from employees in payment for certificates, to pay return thereon. Consideration of this point is unnecessary, however, as we are of the opinion that it would not be compatible with the public interest for the applicant to issue securities, the proceeds of which are to be invested in property not to be held for, or used in the service of transportation. Our order will accordingly provide that the proceeds of the certificates shall be used for capital purposes.

« The applicant has submitted a statement giving a general estimate of its capital needs which will require expenditures far in excess of the funds to be realized through the proposed sale of certificates. We have not considered it necessary to require the applicant to make a more specific showing in this respect inasmuch as the purpose of issuing the certificates is not to raise funds for capital expenditures but, as is stated in the application, to create a feeling, on the part of the employees, of participation in the earnings of the company in order that they may gain a spirit of interest in the welfare of the applicant beyond that of mere wage earners. It is stated that the inauguration and operation of the investment plan proposed will secure for the applicant, from its employees, a spirit of loyalty and faithfulness which will result in more efficient and loyal service to the applicant, and thus enable it more efficiently to serve the public.

« From estimates based on the experience of industrial companies conducting plans of investment similar to that proposed, it is expected that approximately 50 % of the applicant's employees will avail themselves of the opportunity to participate in the plan, and, from their earnings, invest 5 % of their total wages or salaries per year. It is stated that at present there are approximately 2 225 employees in the applicant's service earning an average of approximately $185 per month. From this it appears that payments on account of subscriptions, if the applicant's estimate of employees participating is correct, would amount to about $123 500 per annum. However, as payments made by many of the employees on account of their subscriptions would not amount to as much as $100 per annum, the amount of certificates issued during the first year would probably not exceed $100 000.

« It is stated that many of the applicant's employees have expressed a de-

sire to participate in the investment plan. The estimate as to the number who will participate is based on the experience of successful industrial companies showing large net earnings, particularly that of the Ford Motor Company. It is not to be expected, however, that the applicant's employees will be governed by the experience of employees of that company. While the same interests that control the motor company are in control of the applicant the motor company is in no way assuming obligation in respect of the certificates and the community of interest between the applicant and the motor company may be terminated at any time. Employees participating in the applicant's investment plan must look solely to the applicant for payment of the principal of the certificates and return thereon.

« The permanent success of the applicant's plan must necessarily depend, to a large extent, upon the number of employees participating therein. The number participating will be determined, in large measure, by the applicant's ability to show net earnings. Accordingly, in view of the applicant's failure in this respect during past years, the success of the plan is speculative. This, however, is not sufficient reason for holding that the proposed issue is not appropriate for the purpose intended, as hereinbefore set forth. The applicant's representatives have expressed their confidence in the success of the plan and we can see no reason for not permitting it to be tried.

« As has been pointed out, the certificates outstanding at the end of the first year will probably not exceed $100 000. Thereafter the amount outstanding will probably increase at the rate of approximately $123 000 per annum. The amount of the certificates outstanding at the end of a reasonable period for testing the plan should not be sufficient to cause the applicant any serious embarrassment in retiring them, should the plan prove unsuccessful and the employees demand payment of the certificates or the applicant desire to abandon the plan.

« The application before us is not one for the approval of the issuance of securities in the usual and ordinary case. The plan of the applicant pertains more to the matter of relation between it and its employees than to a matter of finance. It is not on an unduly large scale and therefore cannot prejudice the rights and properties of innocent bystanders. Moreover, it is not clear that our approval of the plan is required as within the contemplation of the law.

« The plan is an experiment, but it is only through experimentation that something new can be tested. There is at the present time perhaps no subject of greater importance to the public than the matter of relation between employer and employee. The field of railway operation is vast and the possibilities for improvement in personal relations are unlimited. Every contribution should be welcomed. The world knows the ultimate sponsor of this plan as an industrial genius. It may be that he can contribute something to the field of transportation which will be as epoch-making as some of the things he has introduced successfully in the field of industry. It is our duty to encourage the experiment proposed and give it our sanction in so far as we are authorized to do so. »

MISCELLANEOUS INFORMATION

[656 .252 (.73)]

1. — Pipe staff for flag and lantern signal,

By Clifford A. ELLIOTT,
ENGINEERING DEPARTMENT PACIFIC ELECTRIC RAILWAY, LOS ANGELES, CAL.

Figs. 1 and 2, p. 81.

(*Electric Railway Journal.*)

The Pacific Electric Lines found it necessary to provide a standard staff for flag and lantern signals used as a protection during track repairs. The rules of the road require foremen to place proper protection signals in advance of any work being carried out. These signals consist of a yellow flag during daylight periods and a lantern at night.

The staff used for supporting these signals is made of 3/4-inch pipe with two tees, a nipple and a hook at the upper end. The upright is 4 1/2 feet long and is pointed at the bottom so that it can be readily placed in the ground. A reducing tee 3/4 inch to 1/2 inch is screwed to the upright The small end of the tee is bushed and a 1-inch iron hook is provided for hanging a lantern. A nipple is screwed into the 3/4-inch end of the tee and another standard 3/4-inch tee is screwed to this. This latter tee forms the support for the flag. The tee for holding the flag is placed at an angle, as it was found that this was most suitable for giving trainmen an unobstructed view of the flag. Figure 2 shows a flag in position.

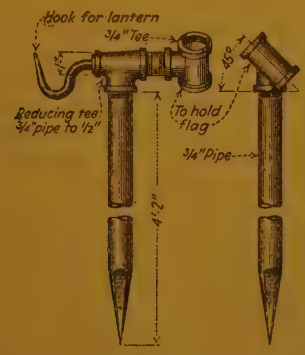


Fig. 1. — Efficient flag and lantern staff used by Track Department of Pacific Electric Railway.

Fig. 2. — Flag signal in position for signalling traffic.

[385 .15]

2 — State railways.

(*The Engineer.*)

A decided change of view as to the State ownership of railways is gradually coming over most countries. A year ago, the « Conseil Supérieur des chemins de fer » in France gave a three-to-one vote in favour of its single State-owned railway being given back to private operation, in which the only public bodies to share were to be the Chambers of Commerce. In Italy the railways — certainly all the minor lines and possibly the major lines, too — are to be turned over, as practically a free gift, to company ownership. The only payment asked for is for the stores; for the track, rolling-stock and goodwill no charge is to be made. Moreover, the State will guarantee a minimum gross revenue per kilometre of line and will not expect to share in any profits until 7 % dividend is being paid. In Belgium matters have not moved as quickly. But there, the railways are to be put upon a commercial basis. Parliament is to have no voice in their administration, and a « Régie » is to be created to which their working is to be transferred. The Minister will remain, but only as a medium between the railway administration and the Government. He will regulate the issue of capital and present the railway budget, which first will be prepared by the administration and submitted to the Minister for his approval (1). Under the League of Nations, Sir William Acworth, in collaboration with Dr. Herold, one of the chief officials of the Swiss State Railways, has been investigating the problems of the Austrian Railways, where an average of seventeen men were employed to every kilometre (twenty-seven men to every mile) of railway. Commercial management is to be established, and it is said that Sir William is of opinion that if the people will support the new administration, their railways will be fully solvent in about two years time. Of Germany it is, of course, difficult to forecast, even the immediate future, especially should her railways be operated as security against reparations. Lastly, there is Spain. Company ownership prevails there, but the State has immense power. The companies have long been in dire difficulties because they could not obtain consent to tariffs being raised to meet the higher pay of the men. It is beginning to be recognized that the situation urgently needs handling. Probably an increase in rates may be sanctioned, accompanied possibly by some sort of co-partnership between the Companies and the Government.

The State ownership of British railways has now very few supporters. Their control by the Government from August 1914 to August 1921, killed the enthusiasm for nationalisation of railways, with that of mines and other public and semi-public services. Something may have to be done with the railways in the Irish Free State, but grouping is likely to be the remedy for their weakness. That is the wish of Mr. Cosgrave's Government. Were it rejected, the alternative would be that recommended by the Commission appointed by the then provisional Government — see *The Engineer* of 10 November last — namely, that the Government should purchase the railways, but that they should be administered independently of the Government. Federal control of the United States railways killed State ownership there, too. The late president Harding, speaking in Kansas City

(1) The Belgian Government presented to Parliament, the 25th of June 1919, the scheme of a law instituting a « Régie » of the State railways. Owing to the dissolution of Parliament, this scheme was dropped before it could be discussed, and the Government did not bring it forward again.

The Government has just decided to reserve the Régie's scheme and to investigate the realization of the financial autonomy of the railways of which the receipts and expenses would henceforth be independent of the operations of the Exchequer.

(*Editor's note.*)

on 22 June last, said : « The railroad question is no theoretical problem. When the Government undertook operation during the war and standardised wages and was caught in the sweeping current of mounting cost, it created a situation to ignore which would quickly develop a national menace. At an awful cost, we learned the extravagance and mounting burden of Government operation. Yet there are to-day very insistent advocates of Government ownership. Frankly, I do not share their views. Our political system has not reached a state of development when we can insure proper administration. I believe it would be a colossal blunder which would destroy initiative, infect us with political corruption, create regional jealousies and impose incalculable cost on the public treasury. » It is only when countries need developing that their railway systems must, almost of necessity, be State owned. Such is the case in South-Africa As Sir E. H. Walton, the High Commissioner of the Union of South Africa, said at the Institute of Transport dinner last May, the country there had been developed by the railways. The rich lines provided the profit wherewith to build new railways, and when the latter, following on the development of the country, were paying, they, in turn, provided for new lines into undeveloped country. The ten to twelve thousand miles of railways could never have been constructed without a Government system of control and without such a system there never could have been the progress that had been made. We not only agree with the High Commissioner as to the wisdom of this policy in South Africa, but go further and say that the railways there set an example to all State-owned systems in the world and to the majority of those company-owned. The cause of this excellence does not, however, lie in the fact that South African railways are Government-owned, but in the ability of those who administer them and in the confidence shown by Governments, traders and the public in those at the head of railway affairs. So far for European, American and African railways. Let us now turn to those of India. In India, for the same reason that decided the question in South Africa, nearly all the railways are State-owned. But though State-owned, only three important lines — the North-Western, Oudh and Rohilkhand, and the Eastern Bengal — are State worked; the Bengal Nagpur, East Indian, Great Indian Peninsula, Bombay, Baroda and Central India, and the Madras and Southern Mahratta are company worked. A Committee, presided over by Sir William Acworth, which investigated the question of the future of Indian railways consisted of ten members. All were agreed that administration by companies of English domicile should not be continued after the termination of the existing contracts between the Secretary of State and the companies. They were also agreed that hybrid companies of English and Indian interests were impraticable. Five members, including the chairman, were in favour of direct State management, whilst the other five recommended a continuance of the existing conditions, with the proviso that the operating companies should be domiciled in India. It is important to note that the latter five consisted of two ex-Presidents of the Indian Railway Board, whilst one was a railway administrator, one represented European commercial interests in India, and one was an Indian commercial magnate. The report pointed out that three of the members of the Committee had no previous knowledge of India, and that three represented life-long experience of Indian railways. The three last named and one of the former three opposed State management. Many of the valuable recommendations unanimously made by the Committee have been adopted, but nothing has yet been announced as to the future administration of the company-managed railways. Broad-minded Indian business people consider that in conceding the establishment of companies domiciled in India, public opinion is being met, and they fear that State management would bring to India those evils which have been experienced elsewhere.

From this concise review of the present position, it will be seen that in Europe and America State ownership of railways is dead or moribund, whilst in South Africa the conditions are such that no other course than

State ownership is conceivable. In India the matter is still in the balance, but must soon be settled one way or the other, as the East Indian contract expires next year, and that of the Great Indian Peninsular in the year after. Opinion is pretty evenly divided between private and State management. There is no preponderating desire to see the management of the railways pass into the hands of the State, and with the example of France and particularly of America to weight the balance, it is likely, and for ourselves we trust it may, tip against that course. But the mere fact that opinion is so accurately divided it is a significant fact. It shows, at least, that no preponderating advantages of State management were brought before the Acworth Commission. When there is no good cause for a change, wise men leave things as they are. Should the decision be of that order, then State ownership of railways and of many other things will have received a blow from which it will scarcely recover in a generation, if ever.

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OFFICIAL INFORMATION

ISSUED BY THE

PERMANENT COMMISSION

OF THE

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

The Triennial « Arthur Dubois » Prize.

(2nd award : 1923-1925.)

We published in the May 1920 number of the *Bulletin* (p. 310) the regulations governing a triennial prize instituted by the Permanent Commission to commemorate the memory of its ex-president, the late Mr. Arthur Dubois.

We believe it may be useful, now that the second period, which started on the 1 January 1923, has commenced, to reiterate briefly the principal points of these regulations :

The prizeman will receive a diploma and a gold medal of the value of one thousand francs. The medal will bear the likeness of the founder on one side. Or, if the prizeman so desires, he will receive a sum of one thousand francs instead of the medal.

The successful candidate will have the right to the title of « Laureate of the Arthur Dubois Prize of 19... (gold medal) ».

The second award will be made on the 1 January 1926 to the Belgian engineer, under 35 years of age when he sends in his paper, who is the author of the best work dealing with the operation or construction of railways. The papers must be sent in before the 1 July 1925.

At least six months before the award is made (that is to say not later than the 1 July 1925) the competitors must forward to the Offices of the Permanent Commission, an account of their work and a declaration that they desire to compete for the prize.

The prize will not be divided. If the special committee appointed by the Commission decide that none of the work merits the prize, the sum not awarded will be added to the capital of the fund. The committee may award one or more bronze medals.

The limit of age of 35 years may be increased to 40 years of age in the case of competitors who served during the late war or who were interned in Germany during it.

The Executive Committee.

NEW BOOKS AND PUBLICATIONS

[385. (09.3 (.71) & 385. (04]

INNIS (HAROLD A.), lecturer in the Department of Political Economy in the University of Toronto. — **A History of the Canadian Pacific Railway.** — One volume in 8vo (8 3/4 × 5 1/2 inches), of VIII + 365 pages. — 1923, Editors : P. S. King & Son, Ltd., Orchard House, Westminster, London, and McClelland & Stewart, Ltd., Toronto. — Price : 12 sh. 6 d. net.

This book is written by an historian and economist, and contains a very complete account of the events and of the political and economic circumstances which accompanied the inception, construction and development of the *Canadian Pacific Railway*. This great enterprise was completed in 1885 and is perhaps one of the best examples that we have of the considerable influence exercised by railways on the development of the economic life of the countries through which they run. For this reason the history of the *Canadian Pacific Railway* is closely bound up with that of Canada itself, and the reader will find, in addition to very complete statistics dealing with the railway, some very interesting facts regarding the commercial activity of this great country.

The first part deals with the history of the economic development of Canada, and describes the situation in the days before the advent of railways. The author then shows the political and financial difficulties which were met with in the different stages of their construction.

The second part, which constitutes the main body of the work, is a complete analysis of the operations of the *Canadian Pacific Railway*. It consists of chapters IV to X, which deal with freight traffic and rates, with passenger traffic, receipts, expenses and the profits on working and of the nature of the capital invested and the interest paid on the same.

The complete text of the Act of the 15 February 1881, which authorised the construction of the *Canadian Pacific Railway*, is given in the appendix.

A very complete bibliography gives a number of books, articles in journals and reviews, and the official documents dealing with the history of Canada and with that of the railway. E. M.